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Vice Chancellor for Research,
Shiraz University of Medical Sciences.
P.O. Box: 71345-1978
Shiraz, Iran
Tel: +98 71 32357282
Fax: +98 71 32307594
Email: vcrdep@sums.ac.ir

ADDRESS:
Journal of Health Sciences and Surveillance System
P.O. Box: 71536-75541
Shiraz, Iran
Tel: +98 71 37251001
Fax: +98 71 37251007
Email: jhsss@sums.ac.ir
Web: http://jhsss.sums.ac.ir

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Listed below are sample references. Journal Article • Raftopoulos H, Ward M, Leboulch P, Hallal AH, Amortegui JD, Schulman CI, et al. Long-term transfer and expression of human beta-globin gene in a mouse. Blood 1997; 90: 3414-22.

• 2. Javan S, Tabesh M. Action of carbon dioxide on pulmonary vasoconstriction. J Appl Physiol. In press 2005 Complete Book

• 3. Guyton AC: Textbook of Medical Physiology. 8th ed. Philadelphia, PA, Saunders, 1996. Chapter in Book

• 4. Young V R. The role of skeletal muscle in the regulation of protein metabolism. In Munro HN, editor: Mammalian protein metabolism. Vol 4. San Diego; Academic; 1970. p. 585-674.

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REVIEW ARTICLE

Effects of Genetically Modified Food on Gut Microbiota in Animal Models: A Systematic Review

Maryam Nejabat[1], PhD Candidate; Mohammadreza Heydari[2], PharmD, MPH, PhD; Parisa Keshani[2], PhD; Hassan Joulaei[2], PharmD, MPH, PhD; Nazanin Nazari[3], MSc

[1]HIV/AIDS Virology, HIV/AIDS Research Center, Institute of Health, Shiraz University of Medical Sciences, Shiraz, Iran
[2]HIV/AIDS Research Center, Institute of Health, Shiraz University of Medical Sciences, Shiraz, Iran
[3]Department of Immunology, Shiraz Medical School, Shiraz University of Medical Sciences, Shiraz, Iran

Correspondence:
Mohammadreza Heydari, PharmD, MPH, PhD;
HIV/AIDS Research Center, Institute of Health, Shiraz University of Medical Sciences, Shiraz, Iran.
Tel: +98 71 37386272
Email: Heydari280@yahoo.com
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Abstract

Background: There are some debates about the possible unintended effects of genetically modified (GM) crops on consumer health. The gut microbiota plays an important role in maintaining the health of the host, especially in gastrointestinal diseases. The current review focuses on the studies with the aim of evaluating whether their outcomes indicate any adverse effects of feeding genetically modified (GM) crops on alteration and the count of gut microbiota.

Methods: A structured literature search was performed independently by three authors on Scopus, Web of Science, PubMed, and Embase on the 1st of July 2019. In total, 333 publications were obtained by the search strategy, which decreased to 306 after excluding the duplicates. Furthermore, experimental studies that have designed a control group and were written in English were included in the review. After reviewing the full texts, 16 studies were included. To access the quality of articles, we used the Cochrane checklist.

Results: Ten publications (62.5%) used 50% or more genetically modified (GM) diet in the treatment group. In 11 studies (68.7%), the duration of animal feeding was 90 days or more. There were no significant differences in the experimental and control groups of both male and female rats on the 90th day; it can be concluded that non-genetically modified (GM) and genetically modified (GM) rice diets did not cause any changes in the gut bacteria. Data analysis of different animal models showed that the most changes in the microbial flora were observed in the chicken and the least in the rat. In the studies in this review, all microbial isolates were anaerobic, and the *Lactobacillus* and *Enterococcus* families were common organisms.

Conclusion: Based on our literature review, we claim that there is not any significant difference in gut microbiota between the control group and the group with a transgenic diet. The mechanisms of the effects of genetically modified (GM) foods on the gut microbiota in animals should be explicated in future studies. Nevertheless, this study provides valuable information for research on genetically modified (GM) foods and whether they are useful or detrimental to human health.

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Keywords: Gastrointestinal microbiome, Animals, Genetically modified, Crops, Agricultural, Diet

Introduction

There has been an exponential growth in the subject of agricultural land cultivation with genetically modified (GM) crops since 1996. In 2016, 20 years later, 185.1 million hectares were cultivated with genetically modified (GM) crops throughout the world (The International Service for the Acquisition of Agri-biotech Applications (ISAAA), 2017).[1] As the cultivation area and marketing of genetically modified (GM) products extend, an increasing number of consumers are becoming familiar with them, which has caused a lot of concern about the possible inadvertent impact of these new products on the environment and public health.[2] Maize, cotton, soybean, and canola are the most common genetically modified (GM) crops.[3] In these crops, a gene has been introduced to either cause insect resistance,[4] such as in the case of Bacillus thuringiensis (Bt) maize, or induce herbicide tolerance, an example of which would be Roundup Ready (RR) soybean. Genetic modification has been done on Bacillus thuringiensis (Bt) crops to cause the expression of one or more Cry proteins from the bacterium Bacillus thuringiensis (Bt) to protect them against insects of the order Lepidoptera.[1, 5] Since 2013, one of the preconditions for authorizing GM crops in the European Union has been 90-day feeding studies on rodents.[1]

Recently, the critical role of the gut microbiota in keeping the host healthy has gained worldwide recognition.[6] There is a functioning and complex microbiota in the gastrointestinal tract of mammals that affects the health of their bodies by playing an important role in intestinal metabolism. For example, the gut microbiota is tasked with energy extraction from indigestible foods, the development of the gut immune system, and the synthesis of crucial vitamins.[7] Numerous studies have shown that intestinal bacteria play an unparalleled role in physiology, intestinal morphology, development of the immune system, and digestion.[5, 8, 9] As a complex and active ecosystem, the gut microbiota is responsible for many critical functions in the host, such as modulating metabolic processes, fermenting undigested energy, harvesting nutrients, and detoxifying toxic compounds.[10]

It is a widely recognized fact that many species of bacteria are beneficial, such as *Lactobacillus, Bifidobacterium* and some types of *Streptococcus*, while some other species such as *Bacteroides, Clostridium* and *Enterobacterium* can be dangerous due to their metabolic activities. There are even some species that can be potentially pathogens.[2] The composition of the eaten food can have long-term effects on the microorganisms living in the gastrointestinal tract, which can be characterized by the fecal microbial flora.[7] Some research has shown that changes in the structure of the microbiota in the gastrointestinal tract play a role in several conditions, such as inflammatory bowel disease, type 2 diabetes, colon cancer, brain abnormalities,[6] and multisystem organ failure.[11-13] For instance, colonic cancer, constipation, and inflammatory bowel disease can be influenced by the composition and metabolic activities of the microbiota.[2] Hence, certain food safety evaluations have been carried out on genetically modified organisms (GMOs) to identify the intestinal microbiota as a genetically modified organism (GMO) food safety index.[7] Therefore, it is crucial to carefully monitor the composition of gut bacteria in order to achieve a better safety evaluation of genetically modified organisms (GMOs) with regard to their impact on gastric health.[2] Previous studies have indicated some differences between animals fed with GM products and the ones on a non-genetically modified (GM) diet. It has been proposed that genetically modified organisms (GMOs) might influence the health of animals in unknown ways.[7] Furthermore, it has also been suggested that randomly inserting a transgene into the genome of animals may lead to some unintended changes.[2] With the dvent of transgenic technology, scientists have been able to cultivate several genetically modified (GM) crops using Cry proteins extracted from Bacillus thuringiensis (Bt)-targeting pests.[10] In the past 20 years, there have been numerous trials on animals aiming to assess the safety of GM crops cultivated with Cry proteins.[10]

The present review focuses on previous studies in the field aiming to determine whether they reported any adverse effects on genetically modified (GM) crops about unintended changes and the gut microbiota count. To this end, we reviewed several experimental studies published in refereed scientific journals that involved feeding genetically modified (GM) crops to animals, rats and mice, pigs/saws, or poultry. Therefore, this study summarizes and discusses the observed effects of feeding genetically modified (GM) crops as reported in the literature.

Methods

Research strategy: The PICO elements for this study are P (problem): Genetically Modified Food; I (intervention): genetically modified (GM) feeding; C (comparison): Not genetically modified feeding; and O (outcomes of interest): Gut microbiota composition. A structured literature search was performed independently by three authors on Scopus, Web of Science, PubMed and Embase on 1 July 2019 (Table 1). In total, 333 publications were obtained by the search strategy, which decreased to 306 after omitting duplicates. Moreover, the review only included publications that were in English. The references included in the selected publications were used to find other peer-reviewed publications on the subject ("snowballing"). To access the quality of articles, we used the Cochrane checklist.

Table 1: Search strategy to study the impact of feeding GM crops on gut microbiota

Key words	
Gastrointestinal Microbiome" OR "Gut Microbiome" OR "Gut Microflora" OR "Gut Microbiota" OR "Gastrointestinal Flora" OR "Gut Flora" OR "Gastrointestinal Microbiota" OR "Gastrointestinal Microbial Community" OR "Gastrointestinal Microflora" OR "Gastric Microbiome" OR "Intestinal Microbiome" OR "Intestinal Microbiota" OR "Intestinal Microflora" OR "Intestinal Flora" OR "Enteric Bacteria	Genetically Modified Food" OR "GMO Food" OR "Genetically Modified Plant" OR "GMO Plant" OR "Genetically Engineered Plant" OR "Transgenic Plant" OR "Genetically Modified Organism" OR "GMO Organism" OR "Genetically Engineered Organism" OR "Transgenic Organism" OR "Genetically Modified crop" OR "Genetically engineered crop" OR "Genetic manipulated crop" OR "Transgenic crop" OR "transgenic food" OR "genetically altered food" OR "genetically altered crop" OR "genetically altered plant" OR "Bioengineered food" OR "Bioengineered crop" OR "Bioengineered plant

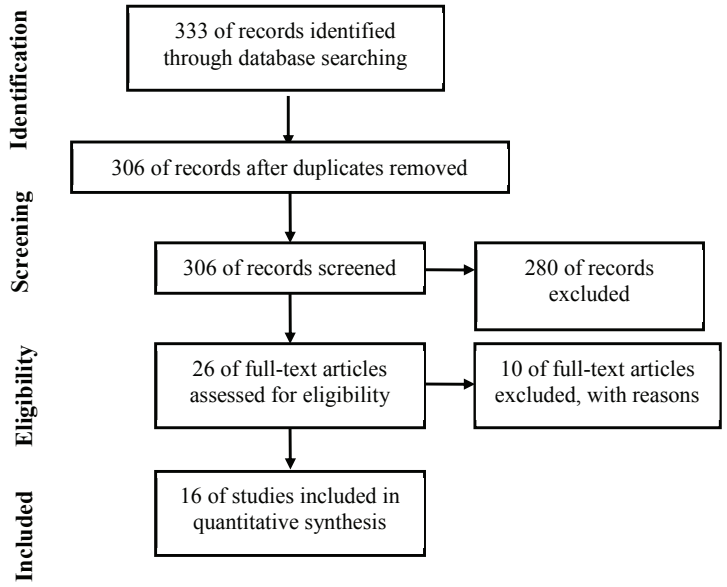

Figure 1: Flowchart of information through the different phases of a systematic review

The collected articles were considered and scored independently by three authors and each publication which had the eligibility criteria was included in our review.

Inclusion criteria: All experimental animal studies which assess the impact of genetically modified (GM) crops on the gut microbiota.

Exclusion criteria: Experiments without control group, the Cochran quality scale under 7 articles which were written in Persian or non-English language and articles the full text of which was not found.

In this regard, abstract screening was used to select 26 relevant publications. After the review of the full texts was done, 16 studies were included (Figure 1).

Results

We reviewed 16 scientific publications up to 1st of July 2019, which had our inclusion criteria. The characteristics of the articles are shown in Table 2. Ten publications (62.5%) used 50% or more genetically modified (GM) diet in the treatment group. The duration of treatment varied from 2 to 420 days. In 11 studies (68.7%), the duration of animal feeding was 90 days or more. Nine studies were conducted on rats, 4 on pigs and saw, 2 on broilers, and 1 on mice. In all, 8 studies fed their animals with genetically modified rice, 3 maize, 2 corn, 1 apple, 1 soybean, and 1 canola. Most of the studies (75%) were performed in China, and a few of them were done in Ireland (3 studies) and New Zealand (1 study). All 3 studies in Ireland were done on pigs, all of which were fed with maize. One study in New Zealand was done on mice fed by apple. One experimental group included animals from multigenerational studies. Only 2 multigenerational studies were conducted on Bacillus thuringiensis (Bt) maize in saws[14] and on rice in pigs.[10] Results are shown briefly in Table 3 and reported separately based on bacteria family.

Entrobacteriacea

Liu et al., Yuan et al. and Buzoianu et al. showed that there was a larger number of Enterobacteriaceae in the genetically modified (GM) group as compared with the non-genetically modified (GM) group.[2, 10, 14] In Xu et al.'s study, the number of *Escherichia coli (E. coli)* was increased in non-genetically modified (GM)group, in contrast with the genetically modified (GM) one.[15]

In contrast to the mentioned studies, in the Zou et al.'s study, there was a significant reduction in all groups about the relative abundance of the Escherichia coli (*E. coli*) subgroup in males and

Table 2: Summary of the characteristics of studies reporting the effect of genetically modified (GM) crops on gut microbiota

	Author	Year	Country	Sample size	Animal	Sex	Study duration	Genetically modified organisms (GMOs) Crop	Percent of genetically modified organisms (GMOs) in diet
1	Wentao Xu	2011	China	36 male and 36 female. divided into 6 groups randomly (n=6 per group),	Sprague–Dawley rats	M/F	90 days	Rice	30%, 50%, 70%
2	Yanfang Yuan	2011	China	36 rats (18 male and 18 female) six groups (six rats per group)	Sprague–Dawley (SD) rats	M/F	90 days	T2A-1 rice	70%
3	Stefan G. Buzoianu	2012	Ireland,	40 (case=9 , control=8)	pigs	M	110 days	Maize	38.88%
4	Stefan G. Buzoianu	2012	Ireland,	18 (9 each treatment)	Crossbred pigs	M	31 days	Maize	38.88%
5	Stefan G. Buzoianu	2013	Ireland	9 non- genetically modified organism (GMO), 10 genetically modified organism (GMO)	The saw	M/F	36 weeks	Maize	38.88
6	Yanfang Yuan	2013	China	84 animals divided into 14 groups (six rats/group)	Rat	M/F	90 days	T2A-1 rice	70%
7	Richard V. Espley	2014	New Zealand	30 (each group n=10)	Swiss mouse	M	trial 1=7 days, trial 2=21 days	Apple	20%
8	Xiaozhe Qi	2014	China	Three groups (10 rats/sex/ group).	Sprague-Dawley rat	M/F	90 days	4-114-7 rice	50%
9	Lin Lu	2015	China	160, 20 cages (8 chicks per cage) with 10 cages (replicates) for each treatment.	Arbor Acres commercial male broilers	M	42 days	Corn (PTC)	54.0% during 1–21 days and 61.0%during 22–42 days
10	Kai Zhao	2016	China	Sixty (three groups, with 20 rats in each group (10 male and 10 female per treatment	SPF Sprague Dawley rats	M/F	90 days	Rice T1C-1	60%
11	Tianqi Lang	2017	China	140 (70 male and 70 female). 7 groups 20 rats/group (10 rats per sex).	Sprague-Dawley (SD) rats for	M/F	90 days	Canola RF3	2.5, 5 and 10% (w/w)
12	Penggao Li,	2017	China	Forty (20 female and 20 male)	Sprague-Dawley (SD) rats	M/F	10 weeks	Corn	75.0%, 76.5% and 76.2%,
13	Geng Lili	2018	China	140 (two groups)	Arbor Acres broilers	F	42 days	Rice TT51	100%
14	Qiang Liu,	2018	China	26 pigs (13 females and 13 males) (f0F control group, n=14) and a case group (f0Z group, n=12), 27 offspring of the first generation (f1). control group (f1F group, n=10) and a case group (f1Z group, n=17)	Inbred Wuzhishan pigs	M/F	Fed for f0=360 and f1=420 days	MH86 rice	56-66% by mass based on the composition of rice
15	Shiying Zou	2018	China	140 Seven groups	Sprague-Dawley (SD) rat	M/F	90 days	DP-356Ø43 soybeans	7.5%, 15% and 30% wt/wt
16	Xueqin Zhang	2019	China	140 (Seventy male and seventy female)- 7 groups (10 rats/sex/group)	Sprague-Dawley rats	M/F	90 days	Rice Lac-3	17.5, 35 and 70%

females by the end of the first month (by about 10%) as compared with the baseline, and the reduction continued up to the end of the study. However, these changes were not significant between the groups.[7] Another study by Buzoianu et al.[16] has shown that being fed with genetically modified (GM) maize has had no effect on any of the counts of the cultivable bacteria from this family, whether enumerated in the feces, ileum, or caecum. There has also not been any significant impact on the composition of the caecal microbiota. According to the findings, it is safe to feed genetically modified (GM) maize to pigs in terms of the effects it has on their intestinal microbiota.

Table 3: The impact of feeding GM crops on animal gut microbiota

	Author	Year	Method	Sample region	Bacteria family	Results
1	Wentao Xu	2011	Real-time quantitative PCR (RQ-PCR) based on genus-specific 16s rDNA primers	Cecal sample	Enterobacteriaacea Lactobacillaceae Clostridiaceae Prevotellaceae Rikenellaceae Bifidobacteriaceae Entrococcaceae total anaerobes	These results suggested that genetically modified (GM) had a complex effect on caecal microflora that may be related to the health of the host
2	Yanfang Yuan	2011	"1- real-time quantification method (RM)"	Fecal sample	Enterobacteriaacea Lactobacillaceae Clostridiaceae Bifidobacteriaceae Entrococcaceae total anaerobes	No adverse effects on the numbers of specific bacteria in rat faeces were observed as a result of GMR feeding
3	Stefan G. Buzoianu	2012	Culture-based methods	Fecal, cecal, ilial sample	Enterobacteriaacea Lactobacillaceae total anaerobes	Did not affect counts of any of the culturable bacteria enumerated in the feces, ileum or cecum
4	Stefan G. Buzoianu	2012	"Sequencing of 16S rRNA tags (V4 region; 239 bp long"	Fecal, cecal, ilial sample	Enterobacteriaacea Lactobacillaceae total anaerobes	Some of the differences observed within the cecal microbiotas
5	Stefan G. Buzoianu	2013	16S rRNA gene sequencing	Fecal, cecal, ilial sample	Enterobacteriaacea Lactobacillaceae total anaerobes	Confirms the lack of adverse effects of genetically modified (GM) maize on the intestinal microbiota of pigs
6	Yanfang Yuan	2013	"16S rRNA genes and denaturing gradient gel electrophoresis (DGGE)"	Fecal sample	Lactobacillus salivarius, Bifidobacterium longum, Enterococcus faecalis, Escherichia coli and Clostridium butyricum	Comparable differences were observed in the bacterial composition from GI tract content
7	Richard V. Espley	2014	"Quantified by real-time PCR and cultures"	Colonic content	Total bacteria, Bacteroides-Prevotella-Porphyromonas group, Bifidobacterium spp., Lactobacillus spp.	High-flavonoid apple was associated with changes in gut microbiota
8	Xiaozhe Qi	2014	16S rRNA gene	Fecal sample		Have microbiota profile but not count
9	Lin Lu	2015	"16S rRNA PCR-denaturing gradient gel electrophoresis (DGGE) culture-based methods"	Cecal, ilial sample	Enterobacteriaacea Lactobacillaceae total anaerobes, total aerobes	No adverse effect on the quantity and diversity of gut microorganisms
10	Kai Zhao	2016	"16S rRNA genes and denaturing gradient gel electrophoresis (DGGE)"	Fecal sample	*Salmonella, Lactobacilli, Streptococcus, E. coli*	Cluster analysis of DGGE profiles revealed significant individual differences in the rats'
11	Tianqi Lang	2017	V4 region of the 16S rRNA was amplified by PCR and then sequenced with a MiSeq platform	Fecal sample	*Microbacterium Staphylococcus Clostridium Paracoccus Acinetobacter Psychrobacter Lactobacillus or Lactococcus Bifidobacterium Escherichia coli (E. coli) or Proteus*	Diets containing genetically modified (GM) canola did not disturb the balance of gut microbiota
12	Penggao Li,	2017	"V3–V4 regions of the bacterial 16S ribosomal RNA Illumina MiSeq Sequencing"	Fecal sample	*Lactobacillus, Barnesiella, Ruminococcus, Bacteroides, Clostridium XI and Clostridium XlVa, Ruminococcus 2, Enterococcus, Streptococcus and Oscillibacter Tannerella*	Similar effects on the fecal microbiota were observed after consuming a genetically modified (GM) GM- and non- genetically modified (GM) -corn-based diet for long periods
13	Geng Lili	2018	Sequencing the 16S rRNA	Cecal sample	Enterobacteriaacea Lactobacillaceae total anaerobes, total aerobes	No adverse effects on the broiler intestinal microbiota
14	Qiang Liu,	2018	16S rRNA gene sequencing	Fecal sample	Lachnospiraceae, Rumino-coccacea, Prevotellaceae, Christensenellaceae, Strepto-coccaceae, Lactobacillaceae Enterobacteriaceae, Pseudomonadaceae and Pasteurellaceae	Bacillus thuringiensis (Bt) rice consumption has no adverse effects on the 13 gut microbiota

Furthermore, another study by Buzoianu et al., Lang et al., and Lili et al. reported that fecal, ilea, and ceca counts of Enterobacteriaceae were not affected by Bacillus thuringiensis (Bt) maize exposure. No significant differences were observed in Escherichia coli *(E. coli)* or *Proteus*.[17-19] However, in Buzoianu et al.'s study, the pigs fed with Bacillus thuringiensis (Bt) treatment showed a lower cecal abundance of Succinivibrionaceae than those fed with isogenic treatment (0.17% vs. 1.80%; P=0.08).[17]

Lactobacillaceae

In some studies, the Lactobacillus group had a higher count in non-genetically modified (GM) males at the end of the third month compared with baseline.[7, 15, 20] In Espley et al.'s[21] study, relative to the total bacteria count in the colon, there was a significantly larger number of *Lactobacillus* spp. in the control group on the 2nd day as compared with any other dietary treatment (P<0.01, diet; P<0.01, day; P<0.01, diet 3 day). Also, in the Zou et al.'s[7] study, there were several differences (in the form of decrease in the genetically modified (GM)-fed group in the relative abundance of the *Lactobacillus* group among the males between genetically modified (GM) and non-GM groups.

The number of *Lactobacillus* was decreased in the non-genetically modified (GM) group, but not in the genetically modified (GM) group, which suggests that GM might be putting the intestinal tract at a health risk.[15] In the Li et al.'s[6] research, there was a significant increase in *Lactobacillus* in the group of female rats following genetically modified (GM) corn-feeding as compared with the standard diet, while *Lactobacillus* was the largest genus in all fecal samples (36.13 vs. 12.02%, P<0.05).

In a study conducted by Yuan et al.,[2] compared with the standard group, both GM and non- genetically modified (GM) rice-fed groups showed a significantly higher count of *Lactobacillus* in feces on the 30th day although the count was decreased on the 60th and 90th days. Overall, several studies showed that *Lactobacillus* was not affected by maize, rice, corn in rats, pigs and birds in genetically modified (GM) and non- genetically modified (GM)-fed groups.[2, 11, 17-19, 22]

Although some studies demonstrated this effect happened in the first week of the study, the difference at the end of the study weeks was non-significant.[11] Also, some studies showed that these differences depended on the gender and study area of the gastrointestinal tract, but, overall, it seems they could not find significant differences.

Enterococcus

The genetically modified (GM) and non- genetically modified (GM) groups had many differences in terms of the relative abundance of *Enterococcus* in the males in the Zou et al.'s study,[7] and in genetically modified (GM)-fed animals it was lower in both genders. Yuan et al., Buzoianu et al., and Yuan et al.[2, 11, 17] showed significantly higher numbers of *Enterococcus* in genetically modified (GM)-fed groups compared with non-genetically modified (GM) groups. This difference was also seen in the groups fed with corn, maize and rice, and was also significant in rats and pigs. In other words, the difference observed was not dependent on the animal, gender, or the type of feeding differences.[11, 15, 17, 19]

Clostridiaceae

The studies of the Clostridiaceae genus showed that gender was important in differences in the number of bacteria. In the Li et al.'s study,[6] Clostridium IV was significantly increased in the genetically modified (GM) group of male rats compared with the control group (6.2 vs. 1.68%, P<0.05); however, said it was not the case with the female group.

In another study, *Clostridium sensu stricto* was increased in the corn-fed groups of female rats, while it reduced in the males (P<0.05). There was a significant decrease in the relative abundance of the *Clostridium perfringens* subgroup in both males and females at the end of the first month (by approximately 10%) as compared with baseline, and the decrease continued up to the end of the study.[7]

Peptostreptococcaceae

In the Lili et al.'s study,[11] there were larger numbers of Peptostreptococcaceae in isogenic rice-fed broilers (P=0.02).

Thermoanaerobacteraceae

In Lili et al.'s study,[18] among the more scarce families, there were higher levels of Thermoanaerobacteraceae in genetically modified (GM) rice-fed broilers (P=0.03).

Prevotellaceae

In the Xu et al.'s study,[15] there was not any clear regular pattern for the genome copies of the *Bacteroides–Prevotella* group among 3 subjects in the genetically modified (GM) and non-genetically modified (GM) groups. Espley et al.'s[21] study concluded that regardingthe *Bacteroides-Prevotella-Porphyromonas* group, diet (P=0.03) and day (P=0.05) had significant impacts. In this respect, there was a higher bacteria count in the mice fed with genetically modified (GM) crops as compared with those on the non-genetically modified (GM) diet. In Zou et al.'s[7] study, at the baseline, there was a minor increase in the relative abundance of the *Bacteroides–Prevotella* group in the female groups as time passed, while a

significant decrease was observed in the relative abundance of the same bacteria in the male groups down to about 10% by the end of the first month and 20% by the end of the study.

Bifidobacteriaceae

In Xu et al. and Lang et al.'s studies,[19] there was not any clear regular pattern for the genome copies of the *Bifidobacterium* group among 3 subjects in the genetically modified (GM) and non-genetically modified (GM) groups.[19] Buzoianu et al.[17] reported a low prevalence of the Bifidobacteriaceae group, as they were only observed in the ceca of two pigs fed with the isogenic maize diet and five pigs fed with the genetically modified (GM) maize diet. Based on this finding, they concluded that the abundance of Bifidobacteriaceae tends to be higher in the ceca of pigs that received the genetically modified (GM) treatment than the pigs which received the isogenic treatment (P=0.06). Espley et al.'s[21] study revealed a significantly higher level of Bifidobacterium spp. in the mice that received RG-F and Royal Gala apple flesh and peeled (RG-FP) diets as compared with any other diet in the experiment (P<0.01, diet; P<0.01, day; P<0.01, diet 3 day).[21] In Li et al.'s study,[6] there was also a significant increase in *Bifidobacterium* in the group of female rats fed with the GM diet (2.17% vs. 0.13%, P<0.05). In Zou, et al.'s[7] study, a different trend of diversity was observed for the beneficial bacteria from the *Bifidobacterium* genus. In this regard, there was a significant increase of 1.2 fold in the relative abundance of bacteria from the *Bifidobacterium* genus in the genetically modified (GM) and non- genetically modified (GM) groups at the end of the study compared with baseline. Furthermore, there was a similar final abundance of bacteria from the *Bifidobacterium* genus between the males and females.

Barnesiellac (Porphyromonadaceae Family)

There was also an increase in the second largest genus in Li et al.'s study,[6] *Barnesiellac*, following corn-feeding, and the increase was significant in the group of female rats on the genetically modified (GM) diet (23.42 vs. 9.31, P<0.05), while a significant decrease was observed in *Tannerella* in the same group (1.03 vs. 7.90%, P<0.05), but not in the males.

Akkermansiaceae (Verrucomicrobia)

Li et al.[6] reported an increased level of the *Akkermansia* genus from the Verrucomicrobia phylum in corn-fed groups of male rats, which was significant in the non-genetically modified organism (GMO) group (5.74 vs. 0.32%, P<0.05). However, in male animals, the proportion of Firmicutes in the genetically modified organism (GMO) group decreased significantly compared with the group which received the standard diet (59.59 vs. 80.25%, P<0.05). There was also a significant increase in the proportions of *Verrucomicrobia* and *Candidatus Saccharibacteria* in the non-genetically modified organisms (GMOs) group (5.74% and 1.85% vs. 0.32% and 0.19%, respectively, P<0.05).

Total Bacteria

In Lili et al.'s study,[18] no differences were observed in the total number of aerobes or anaerobes in the ceca of broilers on isogenic rice or Bacillus thuringiensis (Bt) rice diets for 42 days (P>0.05). Moreover, there were no significant differences between broilers-fed Bacillus thuringiensis (Bt) -rice and isogenic-rice diets. There were also no significant differences in the relative abundance of bacterial phyla in the cecum of broilers on Bacillus thuringiensis (Bt)-rice and isogenic rice diets. Overall, 31 bacterial families were detected in the DNA found in the cecal contents of broilers. Furthermore, there were not any significant differences in the relative abundance of the major families under study in the cecal contents of isogenic and Bacillus thuringiensis (Bt) rice-fed broilers.[18] In Zou, et al.'s study,[7] the male group fed with genetically modified (GM) soy beans had different gut microbiota than the non-genetically modified (GM male group. Meanwhile, with regard to other bacterium types, the trends of abundance were similar between GM and non-GM groups. Furthermore, no significant differences were observed between the male and female or genetically modified (GM) and non- genetically modified (GM) groups. In a study carried out by Buzoianu et al.,[17] there were no significant differences in the relative abundance of bacterial phyla in the cecal contents of pigs fed with Bacillus thuringiensis (Bt) and isogenic maize diets. Also, no significant differences were observed between diets regarding the relative abundance of any major families. In addition, Xu et al. concluded that genetically modified (GM) diet had a complicated impact on caecal microflora, and associated this impact with the host's health.[15]

In another study by Buzoianu et al.,[14] for many species, there were significant differences (P<0.05) between genetically modified (GM) maize-fed piglets andthose in the control group during weaning, where genetically modified (GM) maize-fed piglets had a generally higher relative abundance. However, in the case of *Proteobacteria*, there was a lower relative abundance in genetically modified (GM) maize-fed piglets. Overall, authors reported that feeding GM maize to sows and their piglets influenced the intestinal microbiota. However, these were limited effects that had no relationship with any health problems in the sows and their piglets.[14] The patterns of denaturing gradient gel electrophoresis (DGGE) indicated the predominance of bacteria in the ceca of piglets, which suggested that different diets had caused

major changes.[11] Analyzing the relative abundance of the bacteria under study revealed small changes in the B/E ratios (*Bifidobacterium/Enterococcus*) during all research stages and in all groups, with the ratios ranging between 1.19-1.33, which shows a proper balance in gastric health.[11]

Through denaturing gradient gel electrophoresis (DGGE) analysis, Zhao et al.[23] analyzed nine samples over two weeks and found small differences in the fecal samples of both experimental and control groups during the same growth stage. In this regard, they found several common dominant bands, indicating the presence of dominant bacteria in every fecal sample. This finding also showed the low impact of Bacillus thuringiensis (Bt) transgenic rice on the dominant microorganisms that are vital for sustaining rats in the long term. A cluster analysis carried out on denaturing gradient gel electrophoresis (DGGE) patterns suggested that the development of rats had a bigger impact on the intestinal microbiota than the Bacillus thuringiensis (Bt) rice diet.[23] Espley et al.'s[21] study showed a significantly lower total bacteria count for the mice in the control group compared with the mice that received genetically modified (GM) diets. For the mice in the control group, a significantly higher total bacteria count was observed after 7 feeding days as compared with after 21 days. Lu et al.[22] arrived at the possibility that genetically modified (GM) diet might not have an adverse impact on microflora in the ileum and cecum. Furthermore, no significant differences (P>0.05) were observed between birds fed with genetically modified (GM) corn and those in the control group in terms of aerobic and anaerobic bacteria count. Similar bands were detected in the ileum and cecum of birds in the genetically modified (GM) and non-genetically modified (GM) groups. In addition, there were also similar band numbers in the ileum or cecum (P>0.05), which suggests that the two diets resulted in the presence of similar dominant microflora in the ileum or cecum.

Gender-related Studies

In another related study by Qi et al.,[24] in terms of bacterial diversity, a significantly different β-diversity was observed between the genetically modified (GM) and non-genetically modified (GM) groups of male rats on the 30th day and female rats on the 90th day (P<0.05). However, the difference was not significant in the two genders simultaneously, which means that it was not associated with time. As to α-diversity, there were significant differences (P<0.05) between the genetically modified (GM) and non- genetically modified (GM) groups of male rats on the 90th day. The same was also true for the non- genetically modified (GM) and control groups.

As to diet type, there were differences between genders with respect to the relative proportion of phyla and genera. In the females, there were no any significant differences between the four groups in terms of the abundance of major phyla. Meanwhile, in the male groups, compared with the standard group, there was a significant reduction in the proportion of *Firmicutes* in the genetically modified organism (GMO) group (59.59 vs. 80.25%, P<0.05); also, significant increases were observed in the proportions of *Verrucomicrobia* and *Candidatus Saccharibacteria* in the non-genetically modified organism (GMO) group (5.74% and 1.85% vs. 0.32% and 0.19%, respectively, P<0.05).[6] In a research by Zhang et al.,[25] on the 90th day, there were different gut microbiota structures in 70% of the genetically modified (GM) and 70% of the non-genetically modified (GM) groups of both genders compared with their respective control groups (P<0.05). Furthermore, a significant difference was observed between the 70% of the genetically modified (GM) and the 70% of the non-genetically modified (GM) male groups with respect to the gut microbiota structure (P<0.05), while no significant difference was detected between the two female groups (P>0.05). Since there were no significant differences in the experimental and control groups of both male and female rats on the 90th day, it can be concluded that non- genetically modified (GM) and genetically modified (GM) rice diets did not cause any changes in the gut bacteria (P>0.05). However, there were more obvious changes in the gut microbiota of male rats as compared with the females.[25]

Discussion

In-vivo and *in-vitro* studies on animals have shown the significant effect of diet, age, gender, culture, lifestyle, and host genotype on the intestinal microbiota.[19] The microbial composition of the gut varies in different parts of the digestive tract. The gut microbiota is composed mainly of anaerobes, which are approximately 2–3 times more than facultative anaerobes and aerobic bacteria, but most of the bacteria in the cecum are aerobic. In the small intestine, the predominant organisms are enterococci and lactobacilli.[26] In the studies in this review, all microbial isolates were anaerobic, and the Lactobacillus and Enterococcus families were common organisms. Similar results have been achieved using the conventional plate count method and the real-time PCR method. Hence, the method of counting would not be the case for discussion in this study.

Nutrition Contents of Food

As some studies have shown that carbohydrate compounds in transgenic and non-transgenic products can be different[27, 28] and in the study of Buzoianu et al.,[17] carbohydrate was more in transgenic crops, the increase in the population of Enterobacteriaceae and *Bifidobacteria* in the transgenic-fed group can be related to the difference in nutritional content.

In Espley et al.'s research[21] that used apple as genetically modified (GM) food, there was a significant difference between bacterial species in the control group and the group fed with apples. It may be due to the fiber in apple. An association was made between fiber intake and the composition of gut microbiota by means of a decrease in the gut transit and pH. Fiber is considered the main source of fermentation for microbiota, thereby changing the gut microbiota.[29] The action of gut anaerobic bacteria on carbohydrates and their fermentation produces organic acids such as SCFA (acetate, propionate and butyrate), as well as the production of gases such as carbon dioxide and hydrogen, which have a significant impact on the pH of GIT contents. In addition to this change in the pH value, the gastric bacteria composition will also be influenced by the GIT environment. Furthermore, different bacterial compositions will affect the pH value, as well as SCFA characteristics.[11] However, in another study, there were significantly higher counts of *Lactobacillus* and *Enterococcus* in the feces of rice-fed animals on the 30th day. Lactobacillus, a beneficial bacterium can use glucose and lactose and produce lactic acid to prevent the growth of pathogenic bacteria in the gut and also has an important role in the immune system. Based on studies, it can be claimed that the number and diversity of *Lactobacillus* species vary with the type of food and diet.[15]

In the case of transgenic apple, given the genetic alteration in fruit color, coding genes increases anthocyanosides in fruit. In the study of Tugba Ozdal,[30] anthocyanosides increased the population of *Bifidobacteria, Lactobacilli* and whole intestinal bacteria in humans. As to total bacteria, the results are consistent with those of the study of Esply et al.[21] However, the results are not the same for *Bifidobacteria* and the *Lactobacilli* family. This variation may be due to differences between humans and animals. On the other hand, gastrointestinal bacteria are decreased by flavonoids augmentation. Therefore, the researcher should carefully analyze the macro- and micro-nutrients of transgenic foods before preparing them.

In Zou, et al.'s research,[7] the only study that has been done on soybeans as genetically modified (GM) food, soybean had a considerable effect on the increasing frequency of *Biphidiobacterium*, *Clostridium*, Escherichia coli *(E. coli)* and *Bordetella* groups compared with the control group.

Duration of Study

In Buzoianu et al.'s research[16] that studied two generations, no significant difference was observed between bacterial species in the parental and newborn groups. Long-term use of Gm could cause changes in the number and species diversity of bacteria in the gut. For example, in Buzoianu et al.'s study,[14] it was shown that a group fed with Gm maize totally had a higher prevalence of microbiota existing in the gut than the control group (except *Proteobacteria*). Research on the impact of Bacillus thuringiensis (Bt) maize diets on the gut microbiota is limited to studies showing that the hosts' gut microbiota has had great tolerance for Bacillus thuringiensis (Bt) maize. However, this increasing rate could be due to long-term feeding with Gm.[17]

Gender Differences

Although in some animal and human studies such as Mueller et al.'s study[31] it has been found that microbial flora of the two genders are different, in the research reviewed in a recent study, there was no significant difference between genders, due to non-drug group. For this reason, the use of two genders or each of them can be done with no change in the results of studies. However, according to a series of observations, if the study used both genders, it is recommended that each gender should be compared with itself for data analysis. In the study by Adriana Cabal et al.,[32] it was emphasized that nutrition, age, geography, genetics, and lifestyle can have more impact than gender differences.

In Zhang et al.'s research,[25] changes in the gut microbiota of male rats compared with female rats have been evident. Totally, more indicators are changing in male rats compared with female rats. This is because male rats have higher sensitivity in the growth period compared with female ones. Several studies have demonstrated that gender influences gut microbiota composition.[33]

Body Composition

In a study that discussed bacteria based on their diversity,[24] there were some significant differences in microbiota between the genetically modified (GM) group and the control group. These differences in male rats happened on the 30th day, and in female rats it happened on the 90th day. It could be because of the difference in BMI of animals that these two factors are effective for bacterial diversity. Moreover, it seemed that total body fat content also had an impact on the gut microbiota diversity and composition.[29] For example, in a study conducted in the USA, it was shown that the BMI in female animals was related to the overall gut microbiota. Also, in another study carried out in Spain, it was reported that the microbiota explained 31.17%.[8] A study in China found a significantly higher α-variability in the intestinal microbiota of the low-weight group as compared with other weight groups; however, this only applied to women. At the genus level, there was a higher abundance of *Bifidobacterium Coprococcus* and Dialister, as well as a significantly higher abundance of *Phascolarctobacterium*, in obese women, while a higher frequency of *Fusobacterium* was observed in obese men.[29]

Animal Model

Data analysis of different animal models showed that the most changes in the microbial flora were in the chicken and the least in the rat. Since studies by Flemer et al.[34] have shown that rats have the highest microbial resemblance to humans, their reproduction would be faster than pigs and chicks, so rats are suggested to be better animal models than other animals in future similar studies.

Conclusion

Based on our literature review, we claim that there is no significant difference in the gut microbiota between the control group and the group fed with the transgenic diet. Due to the low frequency of certain species and the inadequate information indicating gastric health, we had some trouble describing the differences between genetically modified (GM) and non-genetically modified (GM) groups. In addition, most of the bacterial community residing in the rat gut is still unknown, and most of these bacteria are not able to culture. For future research, we recommend that the mechanism of action of GMR should be clarified in animal guts. However, it still provides invaluable data in GMR, whether it is beneficial for human health or hazardous.

Authors' Contribution

All co-authors have contributed significantly to the conception, design and execution of the experiments, analysis of the findings, and preparation and final approval of the manuscript.

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ORIGINAL ARTICLE

The Effectiveness of an Educational Intervention Based on Teach-back Method with Adherence to Treatment in Patients with Type 2 Diabetes

Saeed Hosseini Teshnizi[1], PhD;
Samiyeh Sadeghpour[2], MS;
Aref Faghih[3], PhD

[1]Department of Community Medicine, School of Medicine, Hormozgan University of Medical Sciences, Bandar Abbas, Iran
[2]Student Research Committee, Department of Nursing and Midwifery, Hormozgan University of Medical Sciences, Bandar Abbas, Iran
[3]Department of Nursing, Faculty of Nursing and Midwifery, Hormozgan University of Medical Sciences, Bandar Abbas, Iran

Correspondence:
Aref Faghih, PhD;
Department of Nursing; Faculty of Nursing and Midwifery, Hormozgan University of Medical Sciences, Bandar Abbas, Iran
Tel: +98 9173641032
Email: aref_faghih@yahoo.com
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Abstract

Background: Patients' adherence to the therapeutic regimen predicts the success of treatment and reduces the complications and severity of the disease. The purpose of this study was to determine the effectiveness of an educational intervention based on Teach-back method with adherence to treatment in patients with type 2 diabetes.

Methods: We performed a quasi-experimental study on 90 patients with type 2 diabetes in the control and experimental groups. Data collection tools were a two-part questionnaire which consisted of the demographic information and the Mandaloo treatment adherence questionnaire with 40 questions. An educational intervention was performed for the members of the intervention group. One week and forty days after the intervention, the two groups filled out the treatment adherence questionnaire again. The gathered data were analyzed in SPSS software version 22 using statistical tests of Wilcoxon, Chi-square, Makhli, Ben Foroni, the repeated-measures variance of analysis, and independent t-test. The significance level in this study was considered less than 0.05.

Results: The mean scores of adherence to treatment in the training group before the intervention, one week, and forty days after the intervention were 120.52±11.49, 157.60±17.96, and 140.65±18.80, respectively; also, in the control group, the mean scores were 113.38±16.89, 150.67±18.58, and 145.02±18. 47, respectively. There was no difference in terms of adherence to treatment between the control and experiment groups (P=0.164).

Conclusion: The findings also showed that adherence to treatment in both groups in all three measurement times was at the fitness level.

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Keywords: Teach-back communication; Treatment adherence; Diabetes mellitus, Type 2; Educational intervention

Introduction

Diabetes mellitus disease is one of the most common non-communicable metabolic diseases with debilitating complications that has a chronic and intangible course.[1] Statistical studies show that the number of people with diabetes in the world will increase from 171 million in 2000 to 366 million in 2030.[2] In Iran, the prevalence of diabetes was reported to be 9.4 (7.4-12.3) among the people aged 20–79 years in 2019.[3] The prevalence of overt diabetes in Hormozgan province was reported to be 0.8% There are no sources in the current document.[4,5]

Beside the severe microvascular complications, which become clinically evident as diabetic

nephropathy, retinopathy or neuropathy, macrovascular complications including coronary artery disease (CAD) are frequent among diabetic patients.[6] DM leads to premature and accelerated atherosclerosis with an increased risk of cardiovascular events. Moreover, myocardial ischemia due to coronary atherosclerosis commonly occurs without symptoms in patients with diabetes.[7] For this reason, successful prevention and treatment of complications are essential and require preventive and therapeutic measures such as physical activity, proper diet, and continued use of drugs. Therefore, one of the important factors that can affect the complications of diabetes is the patient's lack of adherence to treatment. A study by Aghaei et al. showed that a higher percentage of patients in a case-study showed poor adherence to treatment.[8] Therefore, it can be said that patients' poor adherence to treatment is one of the main concerns and clinical problems that health system staff are faced with.[9] Al-Majed et al. in their study have emphasized that the patients' education should be emphasized to create a desire for adherence to treatment.[5] In addition, many other factors are twofold the necessity of patient education, which can be implied to diseases prevention, adaptation to chronic diseases and disabilities, ensuring continuity of care, reducing the incidence of disease complications, and increasing participation in care programs.[10]

Thus, organized education is important as much as, or more than, treatment for controlling this type of illness. The main purpose of education is to develop adherence to treatment among individuals. Providing effective education for people with diabetes improves treatment efficacy and treatment satisfaction and enhances compliance with the treatment plan. This is because people with diabetes may have misunderstandings about their illness and the treatment plan.[11]

In the year 2019, Yen et al. in their study concluded that patients had an important role in their health and their ability to understand health information has a significant impact on their health behavior and outcomes. In addition, teach-back training method is an effective and reinforcing factor in patients' educational programs.[12] In previous studies, teach-back methods have had positive or negative effects on adherence to treatment in type 2 diabetes.[13, 14] Based on assessing the effectiveness of this educational method in the long term, the present study was designed with the aim of determining the degree of adherence to treatment and effect of education on adherence to treatment one week and forty days after the intervention.

Methods

This research is based on a quasi-experimental intervention conducted in the year 2020. The case-study population of the patients with type 2 diabetes referred to Shahid Mohammadi Hospital Diabetes Center in Bandar Abbas city (Figure 1). The sample size was obtained by using mean and standard deviation indices of adherence to treatment in the study by Ghanbari et al. (2020); by considering the first type error rate of 0.05 and 80% power, 41 subjects were estimated for each group, but we increased it to 45 subjects in each group due to 10% probability of attrition during the study.[15] The samples were randomly selected from among patients with type 2 diabetes referred to Shahid Mohammadi Hospital Diabetes Center based on the inclusion criteria.

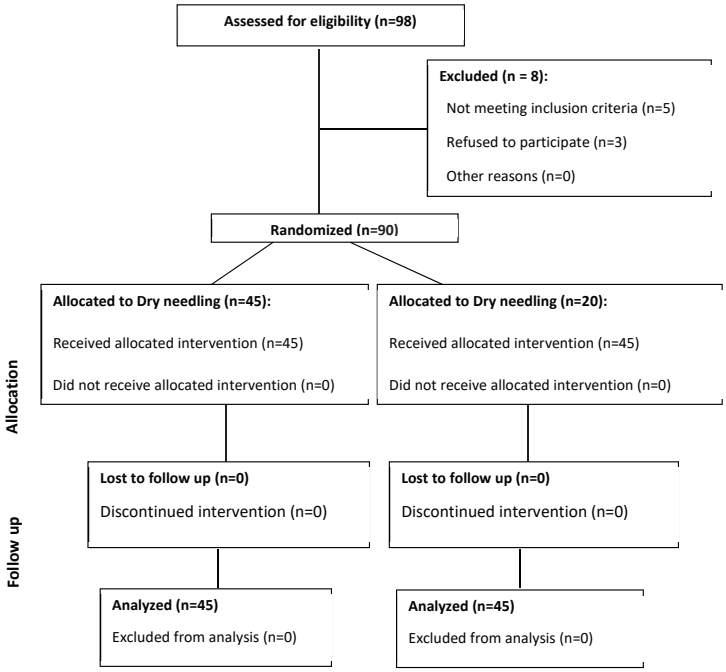

Figure 1: Consort diagram of the studied population

With random assignment, we gave all participants an equal chance of being assigned to each study group, regardless of how representative the participants were. A computer- generated randomization (www.randomizer.org) was used to create an allocation sequence with a block size of five to assign patients to the two study arms, while keeping sample sizes equal across the study groups. We began this process by giving each patient an identification number. If participant #1 in the first block was randomly assigned to the first study group, he/she left the other study group for the other participants in that block. Then, if participant #2 was randomly assigned to the second study group, he/she left the other two study groups for the remaining participants. Then, the process was repeated until all 90 participants had an assigned condition. Allocation concealment was ensured by giving identity numbers to the enrolled patients. Thus, we randomly allocated 90 patients to two equal groups (each group=45 participants): (1) intervention group (receiving educational strategy); (2) control group (receiving usual diabetes education).

Inclusion criteria included age above 30 years, passage of at least one year after their diabetes diagnosis, lack of any mental illness that interferes with the intervention, non-participation in similar educational programs, ability to understand conversation in the Persian language, and lack of difficulty in communication (such as loss of hearing and vision). Exclusion criteria included lack of participation in more than one training session and unwillingness to continue cooperation during the research process.

The data collection tool was a two-part questionnaire. The first part is related to the individual and social characteristics of the participants and has been designed by the researcher and approved by the relevant professors. This questionnaire asks about gender, literacy level, family history in first-degree individuals, diabetes mellitus, intervention, and family income level.

In the second part, the Madanloo treatment adherence questionnaire was used to determine the treatment adherence. This questionnaire was designed in the year 2013 by Madanloo in the field of chronic patients, which includes 40 questions in the areas of making effort for treatment (9 questions), adherence to treatment (4 questions), willingness to participate in treatment (7 questions), adaptability (7 questions), integration of treatment with life (5 questions), commitment to treatment (5 questions), and hesitation in performing treatment (3 questions). The items in this questionnaire are scored using a five-point Likert scale (Strongly 5 points - I agree 4 points - neutral 3 points - disagree 2 points and strongly disagree 1 point); at the end, the scores of all items are added together. The scores range from 0 to 100; scores 75-100 indicate adherence to very good treatment, 50-74 good adherence, 26-49 moderate adherence, and 0 to 25 adherence to poor treatment.[16]

To determine the validity of the Madanloo treatment adherence questionnaire, we used face validity, content validity, and structural validity, the results of which caused the number of questionnaire items to reduce to 40 items. First, face validity was performed in two ways, quantitatively and qualitatively. To determine the qualitative face validity, ten experts examined the items of the questionnaire as to the ease of completing the questionnaire, readability, grammar, style of items, and ambiguity; 12 items merged and 11 items were removed. Finally, the number of items was reduced to the 104 items. In quantitative face validity, for each item, a five-point Likert scale questionnaire with scores from 5 to 1, respectively, with the options "Absolutely important, somewhat important, moderately important, slightly important, and not important at all." was considered and completed randomly by 10 patients; after calculation of the frequency multiplication in terms of percentage and significance, the items were reduced to 89 items. In the qualitative content validity, the opinions and experiences of 15 experts were used in the field of care and treatment of chronic diseases. After deleting and merging the items, their number was reduced to 70 items. Content validity ratio (CVR)1 and content validity index (CVI)2 were calculated to evaluate quantitative content validity. Because the CVR value in 15 items was smaller than the value in the table, then the items were reduced to 55 and after calculating the CVR to 48 items. To determine the structure validity, we also used exploratory factor analysis, which reduced the number of items to 40. Bartlet test result indicated that 25.683% of the common variance by the first factor (Making an effort for treatment), 6.330% by the second factor (Willingness to participate in treatment), 3.934% by the third factor (Adaptability), 3.764% by the fourth factor (Integration of treatment with life), 3.117% by the fifth factor (Treatment adherence), 3.050% by the sixth factor (Commitment to treatment), and 2.377% by the seventh factor (Hesitation in performing treatment) were explained. In the Madanloo treatment adherence questionnaire, also reliability was assessed using the retest method and internal consistency method (r=0.875).[16]

The reliability of the treatment adherence questionnaire was once again calculated for patients referred to Shahid Mohammadi Sampling Center. Reliability or the degree of internal coherence for 40 questions related to the Madanlo treatment adherence questionnaire was calculated 0.944; also, reliability scores for the scales of effort in treatment (alpha=0.863), willingness to participate in treatment (alpha=0.982), adaptability (alpha=0.955), integration of treatment with life (alpha=0.958), adherence to treatment (alpha=0.841), commitment to treatment

(alpha=0.908), and hesitation in performing treatment (alpha=0.977 were obtained. According to the calculated Cronbach's alpha results, this questionnaire has a high reliability.

To comply with ethical considerations, while obtaining permission from the ethics committee of Bandar Abbas University of Medical Sciences and Shahid Mohammadi Hospital Diabetes Center and also justifying the case-study individuals to obtain their consent to participate in the study, the goals, importance, and necessity of conducting a research project for samples were explained; also, written consent froms were signed by them, and they were assured that their information would remain confidential.

Before any intervention, the questionnaire of demographic characteristics and adherence to Madanloo treatment in both groups was completed.

Intervention

The researcher based hiseducational content on the standard guidelines for diabetes medical care and lifestyle management which has been set in the year 2019 by the American Diabetes Association.[4, 17] After translation, it was approved by the relevant professors and then compiled in a simple and understandable language in the form of an educational booklet. After compiling the educational content, the researcher provided the patients with this prepared content in the intervention group in a face-to-face manner; then, he asked the patient to understand the content as he understood it and express it in his/her language. If the patient misunderstood all or part of the material, the researcher explained the same part to the patient again, and then he asked the patient to retell it; this cycle continued until the patient completely understood the educational content. The number of training sessions for each patient was one or two one-hour sessions, depending on his/her level of literacy and readiness to receive training. In the control group, the patients received the ordinary training provided by the staff of the diabetes clinic.

Data Analysis

Qualitative data were described using frequency (n) and percentage (%)and quantitative data using mean and standard deviation (SD) with range. Shapiro-Wilk test, Leven' test, and Machly' test tests were applied to assess normality, homogeneity of variance, and quantitative data, respectively. Repeated measures analysis of variance and independent sample t-test were applied to compare the means of adherence. All statistical analyses were done in SPSS software version 26. P value less than 0.05 was considered as statistically significant.

Results

The mean age of 45 patients in the training group was 50.46±13.17 years (32-80), and in the control group, 49.42±12.90 (minimum age 31 years and maximum age 90 years); the results of independent t-test showed that the mean ages of the intervention and control groups were not statistically significant (P=0.705).

Table 1: Comparison of the frequency distribution of demographic variables in the two training and control groups

Variables		Intervention group		Control group		P value
		Frequency	Percentage	Frequency	Percentage	
Gender	Female	24	53.3	26	57.80	0.67
	Male	21	46.7	19	42.20	
Job	Housewife	17	37.8	17	37.80	0.98
	Worker	5	11.1	6	13.30	
	Employee	11	24.4	9	20.00	
	Self-employment	9	20.00	9	20.00	
	Unemployed	3	6.70	4	8.90	
Marital status	Single	10	22.20	9	20.000	0.64
	Married	25	55.60	29	64.40	
	Divorce	10	22.20	7	15.80	
Education level	Illiterate	11	24.40	14	31.10	0.60
	Under diploma	11	24.40	11	24.40	
	Diploma	11	24.40	13	28.90	
	University	12	26.70	7	15.60	
Income	Low	13	28.90	15	33.30	0.54
	High	22	48.90	24	53.30	
	Very high	10	22.20	6	13.30	
Family history	Has	29	64.40	30	66.70	0.82
	Has not	16	35.60	15	33.30	
Diabetes Complications	Has	21	46.70	19	42.20	0.67
	Has not	24	53.30	26	57.80	
Smoking history	Has	25	55.60	36	80.00	
	Has not	20	44.40	9	20.00	

According to the results shown in Table 1, in the training group, most patients were female (24; 53.3%), housewives (17; 37.8%), and married (25; 55.6%); and had academic education (12; 26.7%), a good income level (22; 48.9%), a positive family history of diabetes (29; 64.4%), and a positive history of smoking (25; 55.6%), and complications of diabetes (25; 55.60%). In the control group, most patients were female (26; 57.8%), housewives (17; 37.8%), married (29; 64.4%), and illiterate (14; 31.1%); and had a good income level (24; 53.3%), a positive family history of diabetes (30; 66.7%), a positive history of smoking (36 people), and complications of diabetes (36; 80%). Comparison of the frequency distribution of demographic variables in the two groups using the Chi-square test showed that in all the mentioned variables, except for the history of smoking in the two groups, the frequency distribution was heterogeneous, so that the history of smoking in the control group was observed significantly higher than in the training group (P=0.01).

Based on the results shown in Tables 2 and 3, comparison of adherence to treatment during the three measurement times in the two training and control groups showed that one week and forty days after training compared to before training, treatment adherence increased in both groups, and this increase was less than forty days later than a week later.

The results of Table 4 show that in the training group a significant relationship was observed between job variables and adherence to treatment (P=0.049). In the control group, there was a significant relationship between job variables (P=0.016) and education level (P=0.018) with treatment adherence.

Discussion

This study examined the teach-back method with adherence to treatment in patients with type 2 diabetes. The comparison of adherence to treatment during the three measurement times in the training and control groups shows that one week and forty days after training, compared to before training, the treatment adherence

Table 2: Adherence to treatment one week after the intervention

Group	Before intervention	One week after intervention	F	P value
Training	11.49±120.52	18.80±140.65	1.973	0.164
Control	16.89±113.38	18.47±145.02		

Table 3: Adherence to treatment forty days after the intervention

Group	Before intervention	Forty days after intervention	F	P value
Training	11.49±120.52	18.80±140.65	122.85	0.001
Control	16.89±113.38	18.47±145.02		

Table 4: The relationship between demographic variables with adherence to treatment and perception of disease in the two intervention and control groups

Demographic		Intervention group		Control group	
		Mean±SD	P value	Mean±SD	P value
Gender	Female	-4.91±18.11	0.928	7.80±23.29	0.637
	Male	-2.62±27.64		11.93±34.55	
Job	Housewife	-6.35±18.75	0.049	6.94±21.01	0.016
	Worker	0.±23.00		12.16±23.33	
	Employee	-3.54±14.64		12.33±23.21	
	Self-employment	-6.55±31.8		30.22±31.32	
	Unemployed	35.66±14.46		15.25±27.29	
Marital status	Single	3.20±22.99	0.462	6.55±24.89	0.672
	Married	-1.44±23.00		7.34±26.68	
	Divorce	-9.50±23.36		7.28±22.96	
Education level	Illiterate	2.72±5.23	0.770	19.85±6.03	0.018
	Under diploma	-5.90±10.60		19.45±8.34	
	Diploma	027±5.90		0.69±7.53	
	University	-5.58±5.06		12.57±7.68	
Income	Low	-0.53±26.15	0.945	12.73±19.80	0.488
	High	-2.45±21.31		10.00±31.28	
	Very high	-3.80±24.50		-3.00±26.51	
Family history	Yes	-196±23.41	0.982	7.80±23.29	0.637
	No	-2.62±22.88		11.93±34.55	
Diabetes Complications	Yes	-3.20±19.29	0.748	11.05±52.62	0.361
	No	-60.20±18.62		1.66±33.52	
Smoking history	Yes	-3.20±19.29		11.05±52.62	0.361
	No	-0.95±27.36		-10.02±25.5	

SD=Standard deviation

increased in the two groups, and this increase was less than forty days later than a week later. In the studies of Ghanbari et al., treatment adherence increased one week and thirty days after training, and this increase was more thirty days after training than one week later. In the mentioned study, the reason for this trend has been reported to be the impact of demographic variables such as age, gender, education on adherence, long duration of education, and a short period of assessment in the second stage.[15] Therefore, for more accurate comparison and accurate results, more studies are suggested to be conducted in this field. In this study, a comparison of control and training groups in general and without considering the time showed that there is no statistical relationship between two training and control groups in terms of treatment adherence. In other words, it can be said that these two groups in terms of treatment adherence haven't any difference together. Patients in two training and control groups in three time periods before training, one week after training, and forty days after training had good adherence to treatment. The study of Tanharo et al.[18] was performed to determine the degree of adherence to treatment of patients with Diabetes disease.

The results show that most patients had poor treatment adherence, and very few patients had very good treatment adherence which is consistent with the results of a study by Vermeire et al.[19] and inconsistent with our study. The results of this study show that there was no different in demographic variables in two intervention and control groups. The results of the present study are consistent with the results of the study of Shojaeizadeh et al.[20] and the study of Khosravi Benjar et al.[21] The results of the present study showed that the distribution of other variables, except for the history of smoking, is almost the same in the two intervention and control groups. The present study, the history of smoking is high in the control group. The present study showed that marital status and gender haven't any effect on adherence to treatment in none of the intervention or control groups. While the results of the study of Jokar et al.[22] show that women have more adherence than men. The results of another study indicate that men with diabetes have better drug adherence. Regarding the history of smoking, the results of our study showed that there is no significant relationship between the history of smoking and adherence to treatment in the two intervention and control groups. While in the study of Jokar et al.[22] it was found that there is an inverse relationship between the history of smoking and adherence to treatment. Regarding the job variable in the present study, there was a significant relationship between job and adherence to treatment in the training group and the control group. Regarding the education variable, the results show that in the control group, there is only a significant relationship between the level of education and adherence to treatment. In terms of income level, there was no significant relationship between this variable and adherence to treatment in the two groups. While in the study of Jokar et al. there was an inverse relationship between economic status and adherence to treatment.[22]

Conclusion

The present study showed that during three times (Before training, one week after training, and forty days after training) the rate of adherence to treatment for one week and forty days after the intervention is higher than before the intervention. Regarding the comparison of the control and intervention groups, the two groups didn't have much difference in adherence to treatment, and in terms of treatment adherence, the two groups had good adherence to treatment in all three measurement times. Regarding the relationship between demographic variables and treatment adherence, it was found that there is a significant relationship between job and adherence in both groups and also between education and adherence in the control group.

Limitations of the Study

The limitation of this study is the mental and emotional condition of patients at the time of completing the questionnaire, which may affect the findings of the study.

Recommendations for Further Research Work

Future studies are required to strengthen the evidence on effects of the teach-back method. Larger randomized controlled trials will be needed to determine the effectiveness of the teach-back method in quality of life, reduction of readmission, and hospitalizations.

Strengths and Weaknesses

Evidence from this article supports the use of the teach-back method in educating people with chronic disease to maximize their disease understanding and promote knowledge, adherence, self-efficacy and self-care skills. The number and hours of training sessions were small, which could affect the outcome of the study

Acknowledgment

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Ethical Confirmation

To conduct this research, the necessary permission was received from the ethics committee of Bandar Abbas University of Medical Sciences (Ethics code: IR.HUMS.REC.1399.282) and Shahid Mohammadi Hospital Diabetes Center of Bandar Abbas.

Conflict of Interest: None declared.

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ORIGINAL ARTICLE

General Dental Students' Views About the Ethics Level in Education, Research, and Provision of Dental Services

Leila Bazrafkan[1], PhD;
Masoud Yousefi[2], PhD;
Javad Kojuri[1], MD;
Mohammad Ansarizadeh[2], PhD;
Habibolah Rezaei[3], PhD

[1]Clinical Education Research Center, Shiraz University of Medical Sciences, Shiraz, Iran
[2]Mamsani School of Allied Medical Sciences, Shiraz University of Medical Sciences, Shiraz, Iran
[3]Cellular and Molecular Research Center, Yasuj University of Medical Sciences, Yasuj, Iran

Correspondence:
Habibolah Rezaei, PhD;
Cellular and Molecular Research Center, Yasuj University of Medical Sciences, Yasuj, Iran
Email: rezaie.habib1@gmail.com
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Abstract

Background: The current study examines general dental students' views about the ethics level in education, research, and provision of dental services.

Methods: This descriptive cross-sectional study was performed on all general dental students at Yasuj University of Medical Sciences selected in the census. The researcher-made questionnaire was prepared online with PorsLine. In this questionnaire, examples of observing or not observing ethics in education, research, and provision of dental services by faculty members were presented to the dental students. Finally, all collected data were analyzed by SPSS software version 26.

Results: 47 students participated in the current study. The participant's mean age was 25.95 with a standard deviation of 3.5. Results of the study showed that the mean and standard deviation of non-observance of ethics in education, the provision of dental services, and research were 3.05±0.9, 2.37±1.03, and 3.04±1.15, respectively.

Conclusion: General dental students reported that the level of ethics in education, research, and provision of dental services by faculty members was unfavorable, so it is recommended that medical education courses related to ethics should be held for faculty members.

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Introduction

The word "ethics" is derived from ethos (character) and the mores (customs). These two words are merged to define how individuals choose to interact with one another. In philosophy, ethics is defined what is good for an individual and society and establishes the nature of duties that people owe themselves and one another.[1] Ethics in Iran dates back to a very long time. Iranians, since the Achaemenes civilization, have followed the ethics in various fields, such as work and profession.[2] Professional ethics is a set of principles and standards of human behavior that determine the behavior of individuals and groups in a professional structure. In other words, the set of ethical principles derived from the nature of the profession or occupation is called professional ethics.[2] Undoubtedly, professional ethics in medical sciences is also one of the most challenging topics, and almost all personnel in this profession, including dentists, encounter ethical issues in their work every day. Advances in technology have also added to ethical issues. However, these challenges have not been addressed in ethics in dentistry courses and the presentation of content, and it is necessary to pay attention to ethical competencies and appropriate ethical decision-making skills in different situations.[3]

Formal education of ethics in dentistry has increased exponentially over the years. Nevertheless, in several developing countries, this issue has not yet been addressed.[4] The main purpose of ethics

education in medical sciences is to train qualified people who can promote the level of health in society while observing justice, dignity, and human rights.[5] To achieve these goals, we need faculty members aware of the principles of ethics in their profession and adhere to these principles in practice. Awareness of dental faculty members on the principles of professional ethics helps them to provide better services and train more ethical people, minimize professional stress, and establish better relationships with patients, colleagues, and other health team members.[6] In fact, faculty members are important factors in shaping the students' moral and professional personality and may hinder their moral development, so it is necessary to pay attention to this issue.[7-11] Although special attention has been paid to the professionalism in the transformation and innovation packages, there are criticisms about its implementation.[12]

Various studies in this regard have been done abroad and in Iran, among which we can mention Elsheikh et al., Kemparaj et al., and Alaeddini et al.[13-15] In Region 5 of Iran, two studies have identified ethical challenges in education, research, and the provision of dental services, from the perspective of faculty members and students. These two pieces of research and othershave not specified the degree of observance of ethical challenges. They have only indicated that problems exist in this regard, while most research has been conducted qualitatively and somehow extract the ethical codes that the faculty members should observe.[16, 17]

Faculty members are considered important factors in shaping the students' moral and professional personality of students; therefore, this study aimed to examine the general dental students' views about the ethics levels in education, research, and provision of dental services.

Methods

This cross-sectional descriptive study was performed in 2021. Participants consisted of general dental students who had started their clinical rotations at Yasuj University of Medical Sciences. The method of selecting the target population was census. The inclusion criteria were general dental students studying in their fourth to twelfth terms. Students who completed less than 90% of the questionnaire questions were excluded from the study.

A researcher-made questionnaire was used to collect the data; the initial format was prepared by reviewing related articles and dissertations. Then, this questionnaire was modified in the focus group meetings held with medical education and dental faculty members. To determine its validity, the authors distributed the questionnaire among 10 specialists in dentistry and medical education, and they were asked, "Which of the questionnaire items does not properly measure what should be measured, and which one is not clear and transparent." Finally, content validity index and content validity ratio of this questionnaire were calculated. Then, for determining the reliability, this questionnaire was given to 30 students to complete, and its reliability was calculated using Cronbach's alpha. After determining the validity and reliability and solving the related problems, we prepared the questionnaire which consisted of two parts, demographic characteristics and 128 specific questions, online with PorsLine and sent via WhatsApp for completion. In this questionnaire, examples of observance or non-observance of ethics in education, research, and provision of dental services by faculty members were presented to dentistry student, showing the importance of the specialized phrases in the questionnaire from very low to very high.

In the next step, the data were entered into SPSS software version 26 for analysis. Finally, descriptive statistics, including mean and standard deviation, were used. The code of ethics was granted by the relevant authorities under the number IR.SUMS.REC.1400.190. If the study participants agreed to participate, the questionnaire was administered to them. All information was kept confidential (Recode of questionnaires no. 1-6 and 10).

Results

47 students participated in the current study. 12 students (5 %) were more than 35 years old, 5 students (12%) were between 30-35, 16 students (45%) were between 25-29, and 14 students (38%) were less than 29 years old. The participants' mean age was 25.95 with a standard deviation of 3.5. The students' grade point average was 15.99 with a standard deviation of 2.81. Nineteen students (41%) were studying in term 12, 7(14%) in term 10, 4(8%) in term9, 11(24%) in term8, 2(5%) in term 6, and 4(8%) in term 4.

The study showed that the means and standard deviations of non-observance of ethics in education, the provision of dental services, and research were 3.05±0.9, 2.37±1.03, and 3.04±1.15, respectively. Table 1 shows the mean and standard deviation of questionnaire items.

As Table 1 shows, the responsibility of faculty members in education and their attention to training the content specified in the curriculum are poor. Therefore, the level of expectation from the student who has just entered the wards is high. Furthermore, the lack of observance of justice by faculty members in scoring, along with injustice and discrimination in the teacher's treatment of the student imposes stress on the student. Moreover, some issues were found to be prevalent, such as positioning and stuttering of faculty members with students, forcing the student to find the patient, not teaching beauty techniques completely to the student due to financial issues, wasting the

Table 1: Mean and standard deviation of questionnaire items

Number	Question	Mean	SD
Ethics in education			
1	Adequate training in theory classes and wards	3.01	1.21
2	Teacher's responsibility in the field of education	2.84	1.30
3	Proper supervision of faculty members to student work in the department	3.20	1.09
4	Observe the time set for training by the teacher	2.93	1.15
5	Complete teaching of the contents specified in the curriculum	2.86	1.26
6	Emphasize theory classes by teachers	3.02	1.16
7	The level of expectation from the student who has just entered the wards	3.78	0.70
8	Creating despair and hopelessness in the student by the faculty members	3.44	1.22
9	Lack of motivation in the student by the teacher	3.32	1.36
10	Having proper order in the faculty by the faculty members	2.90	0.90
11	Teachers' indifference to student education	3.32	1.09
12	Non-observance of professional ethics by faculty members	3	1.11
13	Lack of observance of justice by faculty members in scoring	3.51	1.39
14	Non-standard exam questions	3.38	1.09
15	Lack of proper response of faculty members to student protests	3.79	1.19
16	Do not give feedback to the student by the faculty member	3.35	1.14
17	Non-observance of security issues of test questions	2.86	1.04
18	Not cooperating with a student with a specific medical problem	2.54	.94
19	Injustice and discrimination in the teacher's treatment of the student	3.54	1.35
20	Give stress to the student	3.60	1.23
21	Positioning and stuttering of faculty members with students	3.60	1.37
22	The immorality of faculty members	3.48	1.42
23	The teacher does not respect the student	3.40	1.37
24	Improper treatment with a student in front of the patient	3.02	1.33
25	Teacher misbehavior when asking a student a question	3.11	1.22
26	Destroying student confidence by the faculty members	3.39	1.28
27	Faculty members view about the student as a career competitor	3.27	1.31
28	Do not allow a student to enter the class if there is a delay of less than 5 minutes	2.36	.94
29	Forcing the student to find the patient	3.65	1.43
30	Not taking the student seriously	3.49	1.35
31	Do not allow the student to do practical work in the wards	2.69	1.18
32	The teacher's huff in the classroom	2.40	1.08
33	The teacher blames the student for the teacher' mistake	2.90	1.23
34	Introducing the student to the technicians' personal laboratories	2.91	1.45
35	Forcing students to outsource their work	2.44	1.13
36	Lack of up-to-date educational content of faculty members	3.26	1.25
37	Failure to provide lesson plans to the student	2.92	1.19
38	Inadequate teacher training due to patient protest	2.77	1.12
39	Not teaching completely due to a lack of motivation	3.26	1.26
40	Old age and impatience, and incomplete presentation of lessons	2.66	1.28
41	Incomplete teaching of beauty techniques to the student due to financial issues	3.62	1.41
42	Not being hard on the student by the faculty member to increase his / her evaluation score	2.32	1.19
43	Waste of useful time in student education	3.61	1.35
44	Lack of constant presence of the teacher in the ward	3.03	1.26
45	Unprofessional behavior of faculty members with colleagues due to competition	2.84	1.22
46	Faculty members do not respect each other	2.55	1.12
47	Lack of commitment of faculty members to the student	3.47	1.37
48	Faculty members reluctance to teach	3.42	1.28
49	Faculty members' lack of commitment to provide service in student education	2.94	1.31
50	Faculty members' reluctance to teach due to welfare problems	2.72	0.97
51	Lack of accuracy and focus of the faculty members in the ward	2.65	0.94
52	Having a gender perspective on the student	3.13	1.36
53	Do not allow the student to do patient work and learn	2.86	1.20
54	Obliging a student to purchase equipment from a particular company by a faculty member without a scientific reason	2.01	1.01
55	The role of the teacher is not a role model for the student	2.68	0.99
56	Lack of special privacy between the faculty member and student due to being too intimate	2.27	1.01
57	Comparing the quality of work of novice students with faculty members and ridicule that work	2.45	1.15
58	Taking a repetitive exam from students and not designing a new question	3.18	1.43

Number	Question	Mean	SD
59	Abuse of managerial position by the teacher	3.01	1.28
60	Passing students despite not completing their recovery	2.99	1.41
61	Passing a student due to passing the basic science exam	2.69	1.26
62	Injustice in scoring due to orders	3.52	1.38
Ethics in research			
1	Extraction of the patient's teeth due to proofing teeth by the faculty member	1.77	.85
2	Breaking the rotary file in the channel by the faculty member	1.66	.91
3	Faculty members are not responsible for more complex cases	2.94	1.38
4	Inattention and inaccuracy of faculty members in the initial examination of the patient	2.56	1.10
5	Inappropriate treatment of the patient by the faculty member	1.89	.97
6	Waste of patients' time by the faculty member	3.07	1.13
7	Receive radiation many times by patient due to lack of supervision of student by the faculty member	3.08	1.18
8	Confirmation for the patient without performing periodontist surgery	2.23	.99
9	Prioritize student scores over patient profits	2.38	.96
10	The insignificance of the patient for the faculty member	2.77	1.13
11	The patient's treatment is incomplete due to the late presence of the faculty member	3.29	1.20
12	Failure to obtain informed consent from the patient by the faculty member	2.37	1.08
13	Injury to the patient	2.52	1.02
14	Prefer his/her profits over the profits of the patient by the faculty member	2.45	1.14
15	Impose additional costs on the patient if no treatment is needed	2.07	.97
16	Improper treatment for the patient for economic gain	1.88	.84
17	Failure to complete the patient's treatment due to his miscalculation	1.98	.89
18	Perform non-specialist work for the patient	1.89	.72
19	Doing unrealistic advertisements by dentists	2.15	1.12
20	Referral of patients to a special radiology clinic by dentists	3.14	1.42
21	Use of substandard materials in dentistry	2.81	1.31
22	Taking poor quality radiology photos by the radiology clinic and incurring costs	2.64	1.26
23	Refer patients to specific pharmacies to purchase medication	1.80	.99
24	Failure to treat the patient due to patient misbehavior	2.53	1.23
25	Refer the patient to specific centers to purchase the required equipment	1.92	.96
26	Charging the patient extra due to being miscalculated	1.72	.99
27	Lack of awareness of patient rights	2.51	1.32
28	Not blaming yourself when hurting the patient	2.64	1.25
29	Damaging the reputation of colleagues without a scientific reason	2.12	1.10
Ethics in dental service			
1	Lack of welcome and support of faculty members for students in the field of research	3.32	1.49
2	Faculty members do not pay attention to student research interests	3.18	1.23
3	Giving a duplicate title to the student by the faculty member	3.14	1.37
4	Faculty members' lack of interest in research	3.63	1.33
5	Stealing the title of the research from others by the faculty member	2.78	1.32
6	Do not give time to the student by a supervisor or faculty member	3.47	1.31
7	The faculty member does not read the student proposal	2.99	1.23
8	Receive a fee from the student for being a supervisor by the faculty member	1.84	.83
9	Request from faculty member to submit a proposal by the student without any training by the faculty member	3.15	1.35
10	Lack of cooperation of faculty members in research and imposing total work pressure on the student	3.67	1.29
11	Did not act as promised with the faculty member in research	3.21	1.30
12	Imposing additional costs on the student due to the lack of cooperation of the faculty member	3.10	1.20
13	Submit the students' work by the faculty member in their name	3.19	1.41
14	Do research on the patient without informing him	2.13	.96
15	Data generation by students due to lack of supervision by faculty members	2.79	1.18
16	Failure to check the accuracy of the content in the introduction by the faculty members	2.63	1.16
17	Ignoring spelling and writing errors	2.46	.98
18	Commitment service Faculty member's disregard for students' dissertations	2.89	1.29
19	Waste of student time due to lack of cooperation of the teacher	3.59	1.27
20	Decreasing the scientific quality of research	3.59	1.29
21	Spend money on useless topics	3.28	1.20
22	Investigation of superficial issues in research	3.62	1.22
23	Unreasonable praise of dissertations by faculty members	2.83	1.24

Number	Question	Mean	SD
24	Lack of study of the dissertation by faculty members	3.20	1.32
25	Data generation by faculty members	2.46	.99
26	Accepting a supervisor or advisor of a student dissertation without mastering the subject	2.87	1.12
27	Giving unimportant titles to the student	3.37	1.12
28	Abuse of people to advance the dissertation and not thanking them	2.82	1.18
29	Write the student's name as the last name in the article regardless of the activity	3.56	1.18
30	Deleting the names of colleagues in the article without a scientific reason	2.58	.93
31	The faculty member does not listen to the lectures presented in the defense session	2.81	1.07
32	Lack of sufficient knowledge in writing a dissertation	3.12	1.22
33	Forcing students to translate articles by the faculty member for personal reasons	3.20	1.17

valuable time in student education, practicing injustice in scoring due to orders, not having research interest by faculty members, not having cooperation of faculty members in research and imposing total work pressure on the student, wasting the students' time due to lack of cooperation of the teacher, decreasing the scientific quality of research, investigating superficial issues in research, and writing the student's name as the last name in the article, regardless of the activities.

Discussion

The present study aimed to examine the general dental students' views about the ethics levels in education, provision of dental services, and research. According to the results of the present study, ethics in education, provision of dental services, and research does not have a proper status. These results are consistent with the study conducted by Rezaei et al. and Gharaei et al.[18, 19] Rezaei and colleagues conducted a qualitative study in 5 regions of Iran and found many ethical challenges related to the managers and the faculty members, lack of planning and supervision, lack of workforce and equipment, management of faculty member education, exams and inappropriate treatment of students by colleagues and staff faculty members, preference of personal interests over education, actions taken by the student to reduce the faculty member's motivation, and non-observance of professional ethics by the student.[18] The difference between the results of the present study and those of Rezaei's study is that the present study only attended ethical challenges in that faculty members play a role.

The qualitative study of Gharaei et al. in Mashhad found four main themes for the educational problems of Mashhad Dental School from the students' perspective.[19] The difference between the present study and Gharaei's study is that the latter also pays attention to other ethical problems. These challenges reflect that the ethics course in dentistry does not work well and does not nurture what it ought to, which is consistent with Bertolami's article. Bertolami says that the behavior of students does not change after teaching a series of lessons on ethics. He recognized three specific weaknesses in an ethics course; for example, ethics is boring; everything contained within the course is inadequate qualitatively because it does not give an introspective framework for changing actual behavior; and the course is presented in the early semesters of dentistry without linking theory and practice.[20] The following reasons can justify why the ethics program was found unsuccessful in the present study. Perhaps, one of the reasons for the inadequacy of ethics by faculty members was Covid-19 disease, which negatively affected medical education.[21] Moreover, teaching ethics in dentistry has moved from lecturing to interactive methods and group problem solving, while it was found interactive in this study. The inverted classroom teaching method can also be used to teach ethics, as explained in Rezaei's article.[22] Another reason may be lack of attention of the education development center to the issue of ethics education, which was evident in the internal evaluation of this center.[23] Ethics program is often offered in the third year of the program (in the pre-clinic course) and before entering the clinic course, and this theoretical program only introduces people to ethical principles.[24] Moreover, the subjects envisaged in this theoretical course are based only on medical (and not dental) ethics and often relinquish professional differences between medicine and dentistry. Albeit the general principles of medical ethics can be generalized to the subgroups of medical sciences, it does not fulfill all the professional requirements of different groups.[24]

This study showed that faculty members do not observe many ethical issues in education and research, such as justice in scoring and treatment with the student, standard exam questions, cooperation in research, and authorship criteria. Test analysis can improve the test quality and somehow justice in scoring; therefore, it is suggested that the test should be analyzed, and various articles should discuss the test analysis.[25] Rouhi et al. stated that the most important motivating factors for students were faculty members.[26] Faculty members convey the norms of society to shape the behavior, beliefs, and attitudes of students and to cultivate moral virtues in them.[27, 28] Given that it is the faculty member's behavior that affects the student's ethical behavior,[29] the faculty member's ethical misconduct has many negative effects on students. Hence, It is suggested that faculty members should be justified to observe ethical issues.

Plenty of the challenges this study elicited are

similar to the results of Khaghanizadeh's survey. In their survey, the educational challenges of medical ethics related to faculty members include codes such as having weak interaction with students, giving no feedback to students, neglecting the students' interests, ignoring patients, preferring personal interests, disrespecting patients, and knowing weakness.[30] Hence, it is suggested that educational programs should be held for faculty members. In addition to the modification of the ethics course in dentistry and the need to train faculty members, establishing a faculty ethics committee that assesses the ethics of managers, students, staff, and faculty members and holding seminars and sessions to appreciate the right ethical behaviors, not just punishing wrong behaviors,[29] are among other solutions to observe ethics in dental education.

Considering that the present research only investigated the students' views about observing ethics by faculty members, it is suggested that future studies should investigate the rate of observing ethica l principlesby faculty members from the viewpoint of all stakeholders. In other words, an educational needs assessment should be done which has been used in many studies.[31-33]

Also, given that this research was carried out at Yasuj University of Medical Sciences and ethics is context-dependent, it is suggested that ethical challenges should be investigated in other metropolitan areas of the country as well and the results should be compared with those of the present research.

In this study, the researchers estimated the content validity and did not take any action regarding structural validity, which was one of the limitations of the present study. Other studies may use factor analysis to cover this limitation.

Conclusion

From the viewpoint of general dental students, the level of ethics in education, research, and provision of dental services by faculty members is unfavorable, so it is recommended that medical education courses related to ethics should be held for faculty members.

Authors' Contribution

All the authors have read and approved the final manuscript. LB, Introduction Writer/(20%); MY, Discussion Writer/(20%); JK, Methodology Writer (15%); MA, Result Writer (20%); HR, Methodology Writer/Discussion Writer (25%)

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ORIGINAL ARTICLE

Existence of Different Species of Scorpions (Arachnida: Buthidae) in and Around of Amedical Center, Southern Iran

Kourosh Azizi, PhD;
Mohsen Kalantari, PhD;
Masoumeh Amin, PhD

Research Center for Health Sciences, Institute of Health, Department of Medical Entomology and Vector Control, School of Health, Shiraz University of Medical Sciences, Shiraz, Iran

Correspondence:
Mohsen Kalantari, PhD;
Research Center for Health Sciences, Institute of Health, Department of Medical Entomology and Vector Control, School of Health, Shiraz University of Medical Sciences, Shiraz, Iran
Tel: +98 9307233695
Email: kalantari_m@sums.ac.ir
Masoumeh Amin, PhD;
Research Center for Health Sciences, Institute of Health, Department of Medical Entomology and Vector Control, School of Health, Shiraz University of Medical Sciences, Shiraz, Iran
Tel: +98 9173105344
Email: masomeamin@gmail.com
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Abstract

Background: Scorpions, as a group of venomous invertebrates, are distributed worldwide including the Middle East. These arthropods are distributed throughout Iran, are dangerous to humans and animals, and can cause severe damages and even death.

Methods: In this cross-sectional study, scorpions were collected from different parts in southern Iran such as Kohgiluyeh and Fars provinces using hand catch method with U.V torch. Morphological identification of scorpion specimens was done using specific keys.

Results: Besides different species of scorpions, *Hottentotta jayakari* Pocock, was identified in Amir Oncology Hospital, Shiraz city, Fars province, South of Iran, 1895.

Conclusion: *Hottentotta jayakari* is endemic in tropical regions and its existence in Shiraz with a mild climate seems unexpected. In addition, Amir Hospital is an oncology treatment center and this scorpion was caught on the hospital grounds. It is possible that more species can be identified in this province by conducting more studies.

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Keywords: Scorpions, *Hottentotta jayakari*, *Androctonus crassicauda*, Fars, Iran

Introduction

Scorpions have a wide geographical distribution ranging from tropical to temperate regions. There are more than 1,500 species of scorpions worldwide; out of these, around 5% are dangerous to humans.[1] Scorpionism are common in rural places compared to urban areas. The species richness of scorpion is high in Iran due to its long geological history, vast plains, and high mountain ranges.[2]

Totally, 68 species of scorpions have already been reported. They belonged to 3 families of Buthidae, Scorpionidae, and Liochelidae (=Hemiscorpiidae). Due to geographic area, 52 species were recorded as endemic in Iran. Besides, the genera of *Iranobuthus* Kovařík (1997) and *Polisius* Fet, Capes & Sissom (2001) were reported from endemic areas in Iran (Karataş, Garkheloo, & Uçak, 2012).[3, 4] In this country, scorpions and scorpionism are have caused health problems which have threatened many people's lives over the years, imposing fear, worries, and medical costs.[5]

In total, 117 species of scorpions within six families (Buthidae, Diplocentridae, Euscorpiidae, Hemiscorpiidae, Luridae and Scorpionidae) and 27 genera have been reported from the Arab countries of the Middle East. In Bahrain, only four species are known to be found in this country. These species are: *Androctonus crassicauda*, *Buthacus nigroaculeatus*, *Leiurus arabicus*, and *Orthochirus innesi*. The scorpions of Iraq were extensively studied with a total of 25 species in five families. Four species were described from Iraq, which could be considered endemic:*Compsobuthus jakesi*, *Hottentotta mesopotamicus*, *Compsobuthus iraqensis,* and *Odontobuthus bidentatus*.[6] In Afghanistan, a case of a

scorpion sting with *Androctonus australis* (Buthidae) has been reported.[7]

Hottentotta zagrosensis, *Hottentotta saulcyi*, *Hottentotta jayakari*, *Hemiscorpius acanthocercus*, *Hemiscorpius lepturus*, *Mesobuthus eupeus*, *Mesobuthus caucasicus*, *Mesobuthus phillipsii*, *Orthochirus sp.*, *Apistobuthus susanae*, *Odontobuthus doriae*, *Odontobuthus bidentatus*, *Androctonus crassicauda,* and *Compsobuthus matthiesseni* are the main species of scorpion in Iran; among them, *A. crassicauda*, *H. achantocercus*, *H. lepturus,* and *Orthochirus sp.* are considered the most lethal scorpions.[8]

So far, the following species of *Hottentotta* have been reported in Iran: *Hottentotta schach*, *Hottentotta saulcyi*, *Hottentotta zagrosensis*, *Hottentotta khoozestanus*, *Hottentotta jayakari*, *Hottentotta navidpouri*, *Hottentotta sistanensis*, and *Hottentotta lorestanus*. Among them, *H. zagrosensis* and *H. saulcyi* seem to be medically important.[4, 9]

Most cases of scorpion stings are related to the southern part of the country; about 80% of scorpion stings were reported from Khuzestan province. Among the different species of scorpions, 12 species are involved in scorpion stings in Fars province, southern Iran. The sting with *H. jayakari* has been first reported from Iran.[10] Different species of *Hottentotta* genus (Family: Butidae) are found in different parts of The Middle East including the Arabian Peninsula, Iraq, Afghanistan, southeastern Turkey, Pakistan, India, and Iran.

The ten species distributed in Iran include *Hottentotta jayakari*, *H. juliae*, *H. khoozestanus*, *H. lorestanus*, *H. navidpouri*, *H. saulcyi*, *H. schach*, *H. sistanensis,* and *H. zagrosensis*. All species are endemic in Iran except *H. jayakari* and *H. saulcyi*. The species of *Hottentotta jayakari* can be found in Qom, Hormozgan, and Fars.[11] *Hottentotta jayakari* is one of the medically important scorpions in Iran.[12]

Methods

Fars Province, with an area of about 122000 km^2 is located in south of Iran. Shiraz city with about 1,869,001 population is one of the most populous towns in Iran and the center of Fars Province (29° 36′ 36″ N, 52° 32′ 33″ E). This region has a moderate climate and is classified as a cold semi-arid climate, and the mean annual precipitation is about 300 mm (Figure 1).

In this study, the specimens were collected from different parts of Shiraz city such as gardens and suburban areas, using hand catch method with U.V torch. The collected specimen was delivered to the Entomology Laboratory; their morphological characteristics were examined and recorded using a diagnostic key.

Results

The scorpions caught in this study were similar to the samples of the previous research.[13] These scorpions included *Androctonus crassicauda* (7, 50%) (Figure 2), *Hemoscorpius leptorus* (4, 28.6%) (Figures 3 and 4), and *Mesobuthus eupeus* (2, 14.3%) (Figure 5). One specimen of *Hottentotta jayakari* (Scorpionida: Buthidae) was captured in Shiraz city on the 1st September 2021 (1, 7.1%) (Figure 6) (Table 1). The exact location of this sample was Amir Onchology Hospital. We measured the crucial characteristics of this scorpion which were essential for recognition according to the diagnostic key, using the Vernier caliper. These characteristics include whole body length, triangular sternum, pedipalp length, abdomen, tail segments, pectines, cheliceral movable finger, pectinal teeth count, and telson that were gaged using a Collis Vernier caliper.

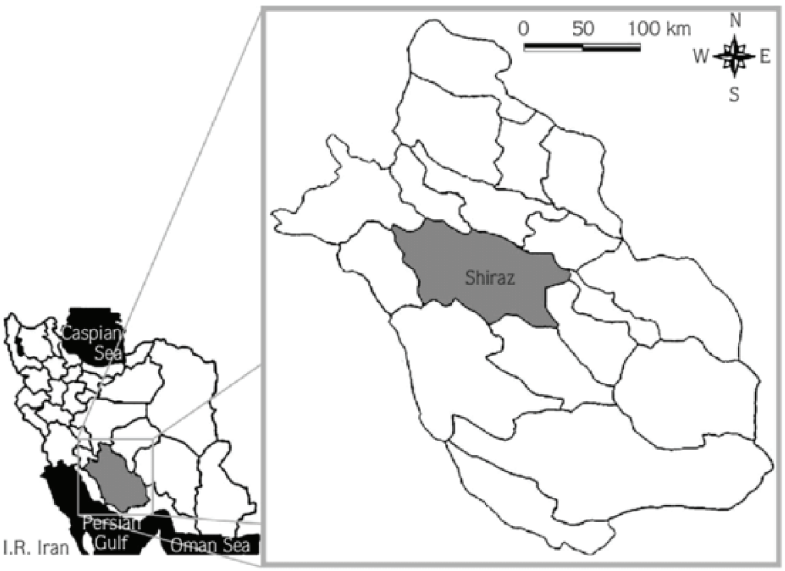

Figure 1: Location of sampling site in Fars Province, Southern Iran, 2021.

Figure 2: *Androctonus crassicauda* (Original Picture)

Figure 3: *Hemiscorpius lepturus* ♂ (Original Picture)

Figure 4: *Hemiscorpius lepturus* ♀ (Original Picture)

Figure 5: *Mesobuthus eupeus* (Original Picture)

Figure 6: *Hottentotta jayakari*: (Original Picture)

Table 1: Fauna, Fars Province, Southern Iran, 2021

Species	*A. crassicauda*			*H. lepturus*			*M. eupeus*			*H. jayakari*			Total		
	♂	♀	T	♂	♀	T	♂	♀	T	♂	♀	T	♂	♀	T
Shiraz	1	0	1(20%)	1	1	2(40%)	0	1	1(20%)	0	1	1(20%)	2	3	5

Discussion

In the present study, 5 scorpions which belonged to 4 different species were captured in Amir Oncology Hospital area, Shiraz city, Fars Province, Southern Iran. These species include one *Hottentotta jayakari*, one *Androctonus crassicauda*, two *Hemiscorpius leptorus,* and one *Mesobuthus eupeus*. In this report, the scorpions were caught in the green space of Amir Hospitals. Of course, this case report complements previous research conducted in Shiraz city.[13, 14]

These species are dangerous and their presence in hospital environment is too important. Different species of scorpions have been reported from Iran. The highest statistics of stings and fatalities belong to Khuzestan and Hormozgan.[12]

The bites of the Buthidae family are painful. When these scorpions bite, swelling and numbness at the bite site, and pain, mostly at night occur. Some members of the Iranian scorpion have poisonous and deadly stings, and some others have painful stings. This is the reason why they are medically important.[15]

Hottentata is one of the most important medically genus in Iran. Decreased blood pressure, increased

heart rate, seizures, anesthesia, distraction, restlessness and anxiety, hemolysis, skin ulcers and necrosis, and renal failure have been reported as complications of scorpion stings.

Hottentotta jayakari has been reported in Fars, Qom, Hormozgan, and Sistan and Baluchestan provinces. In these areas, this scorpion is found in warm plains. This finding is similar to those of other studies reported in this province. Also, this scorpion has been reported as a medically important case.[16-18]

The *Mesobuthus eupeus* species belong to Buthidae family and is commonly distributed from Turkey to China, including Iran. Among these species, *Mesobuthus eupeus* is regarded as the most medically important species which is responsible for most cases of envenomation in this area. In Iran, this species has been reported in Ardabil, Azarbaijan, Kerman, Isfahan, Markazi, Mazandaran, Sistan and Baluchestan, Yazd, Kohgiluyeh and Boyer-Ahmad, Semnan, Fars, Khuzestan, Hormozgan, Kermanshah, Golestan, Tehran, Kurdistan, Ilam, Khorasan, and Qom provinces.[19-21]

The black scorpion *Androctonus crassicauda* is the second most frequent species of scorpion in Fars province of South Iran. It is very dangerous since its venom affects the nervous system. In Iran, this species has been reported in Bushehr, Semnan, Khuzestan, Ilam, Kurdistan, Khorasan, Kermanshah, Kerman, Sistan and Baluchestan, Qom, Azerbaijan, and Ardabil provinces.[13, 21]

Hemiscorpius lepturus is a species of scorpion in the Hemiscorpiidaefamily. It is found in deserts of the Middle East, especially in southern Iraq and Iran. *H. lepturus* is the only scorpion not in the family Buthidae that is potentially lethal. In Iran, this species has been reported in Semnan, Fars, Khuzestan, Kurdistan, Hormozgan, Bushehr, Ilam, Lorestan, Kermanshah, Isfahan, Hamedan, Kohgiluyeh and Boyer-Ahmad, and Kerman provinces.[11]

Conclusion

Hottentotta jayakari, *Androctonus crassicauda*, *Hemiscorpius lepturus,* and *Mesobuthus eupeus* are endemic in tropical regions of Fars province, and its existence in Shiraz with a mild climate seems unexpected. In addition, Amir Hospital is an oncology treatment center, and these scorpions were caught on the hospital ground. It is possible that more species can be identified in this province by conducting more studies.

Ethics Statement

The research plan was approved by the Shiraz University of Medical Sciences research ethics committee with the ethics code of IR.SUMS.SCHEANUT.REC.1401.134.

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Authors' Contribution

MK and KA contributed to the study design. MA identified the scorpion species and KA and MK confirmed the morphological identifications of scorpions. MA wrote, and edited the figures of the first draft. All authors read, edited, and approved the final manuscript.

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Conflict of Interest: None declared.

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ORIGINAL ARTICLE

The Relationship between Producing Health and Contextual Factors Across Countries: A Panel Data Analysis

Efat Mohamadi[1], PhD; Zhila Najafpour[2], PhD; Mohammad Mehdi Kiani[1,3], PhD; Morteza Mohammadzadeh[4], PhD; Amirhossein Takian[1,3,5], MD, PhD; Alireza Olyaeemanesh[1,6], MD, PhD

[1]Health Equity Research Center (HERC), Tehran University of Medical Sciences (TUMS), Tehran, Iran
[2]Department of Health Care Management, School of Public Health, Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran
[3]Department of Health Management and Economics, School of Public Health, Tehran University of Medical Sciences, Tehran, Iran
[4]Department of Biostatistics, Faculty of Medical Sciences, Tarbiat Modares University, Tehran, Iran
[5]Department of Global Health and Public Policy, School of Public Health, Tehran University of Medical Sciences, Tehran, Iran
[6]National Institute of Health Research, TehranUniversity of Medical Sciences, Tehran, Iran

Correspondence:
Amirhossein Takian, MD, PhD; Health Equity Research Center (HERC), Tehran University of Medical Sciences (TUMS), Tehran, Iran
Tel: +98 9121041412
Email: takian@tums.ac.ir
Alireza Olyaeemanesh, MD, PhD; Health Equity Research Center (HERC), Tehran University of Medical Sciences (TUMS), Tehran, Iran
Tel: +98 9124117610
Email: arolyaee@gmail.com
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Abstract

Background: There are substantial differences in the health outcomes across countries. Then, assessment of the status of health indicators can give us a valuable information to adjust policies to improve the health status in the world. This paper examines differences and relationships of health status and contextual factors.

Methods: This is a multi-country cross-sectional study performed using secondary data of different sources in 2019. We identified indicators that revealed the relationships of health status and health coverage and also contextual factors by expert panel which consist of two categories of indicators: (1) producing health indicators as dependent variables (Life expectancy, Healthy life expectancy, Maternal mortality ratio, Under-five mortality rate and Universal Health Coverage (UHC) service coverage indicator); (2) contextual indicators as independent variables (Current Health Expenditure, Skilled health professionals density, Population density and Government Type). Also, countries were categorized based on the income level and six regions of World Health Organization (WHO). We used SPSS 20 software for a descriptive analysis and R 2018 software for statistical analysis and also drawing of scatter charts.

Results: Results showed a considerable gap between the average of life expectancy (84.2 vs. 53 years) and healthy life expectancy rate (72-63.3 years). This disparity was observed in the Maternal mortality and Under-5 mortality rate (from 882 to 3 per 100000 live births), (5 is 2.1 and the highest is 127.3). Although there was a marginal correlation between population density indicator and life expectancy, healthy life expectancy, and under-5 mortality rate indicators (±0.2), there was no correlation between population density and maternal mortality rate with UHC (P>0.05).

Conclusion: There is a considerable difference between countries in producing health indicators based on contextual indicators; a comprehensive health system approach that can result in improvement in the health outcome.

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Keywords: Produce health, Sustainable development goals (SDGs), Health, Policy, Contextual factors

Introduction

The world health organization has defined health as the state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity.[1] Health pattern, in the late 20th century, focused on individual's

health and diseases. Gradually, this was replaced by a social pattern, in which health is an outcome of a set of factors such as social, economic, cultural and environmental, housing, employment and society's circumstances. In other words, lately the concept of health has become wider and includes major aspects of human life and his environment (such as environmental, physical, social and economic issues) and is not limited to the lack of disease or individual health.[2]

The context of people's lives determines their health, so blaming individuals for having poor health or crediting them for good health is no longer suitable. Individuals are unlikely to be able to directly control many of the determinants of health. These determinants—or things that make people healthy or not—include the above factors, and many others such as economic and social status, or income levels are linked to better health. The greater the gap between the richest and poorest people, the greater the differences in health. Access to health care services is among other important factors that affect health status.[3-5]

Given the current health inequities between different countries and the emphasis on humans and their needs as guarantees for health, an emphasis has been put on health (health security) as a main element of human safety in ranking both developed and undeveloped countries. Accordingly, on Sep 25, 2015 the United Nations (UN) passed the progress order "Transforming our World: the 2030 Agenda for Sustainable Development".[6] The Sustainable Development Goals (SDGs), also known as the Global Goals, were adopted by all UN member states in 2015 as a universal call to action to end poverty, protect the planet, and ensure that all people enjoy peace and prosperity by 2030. The 17 SDGs are integrated; that is, they recognize that action in one area will affect outcomes in others, and that development must balance social, economic, and environmental sustainability.[6, 7] Through the pledge to Leave No One Behind, countries have committed to fast-track progress for those furthest behind first. That is why the SDGs are designed to bring the world to several life-changing 'zero', including zero poverty, hunger, AIDS, and discrimination against women and girls. Everyone is needed to reach these ambitious targets. The creativity, knowhow, technology, and financial resources from all of society are necessary to achieve the SDGs in every context.[8] A considerable number of these goals are (directly or indirectly) related to health and its improvement.

To evaluate the status of these goals, researchers have developed 47 indicators for health status.[8] SDGs have set some minimums for health indicators for countries to reach, but evaluating these indicators in various countries has shown a great inequity between them.[8, 9] A child born in a high-income country is at risk of death in the first month, which is only one-tenth the risk for a child born in a low-income country. At the country level, neonatal mortality rates in 2020 ranged from 1 death per 1,000 live births to 44, and the risk of dying before the 28th day of life for a child born in the highest-mortality country was about 56 times higher than in the lowest-mortality country nationwide; infant mortality rates in 2020 ranged from 1 death per 1,000 live births to 44, and the risk of neonatal mortality in the highest-mortality country was about 56 times higher than the lowest-mortality country.[10] Therefore, performance on the UHC effective coverage index increased from 45.8% in 1990 to 60.3% in 2019, yet there is inequality in this index at national-level; UHC effective coverage in 2019 still spanned from 95 or higher in Japan and Iceland to lower than 25 in Somalia and the Central African Republic.[11] Assessment of the causes of inequity and the status of these indicators in countries with different context can provide us with valuable information on identification of determinants of health status; by using them we will be able to adjust policies on national and international level to improve the health status.[12, 13]

With consideration of SDGs and their ultimate goal based on elimination of inequalities in essential health indicators, and also after several years in implementing the SDGs, we aimed to answer the question "Is there still a difference in producing health in countries with different social-economic statuses?" and "How much is the difference?"

Methods

This is a multi-country cross-sectional study performed using secondary data of different sources in 2019. This study aimed to determine the relationship between producing health indicators and contextual indicators of countries.

This study consisted of three key steps. The first step was indicator selection; we conducted a qualitative analysis, i.e. literature review and collecting the experts' opinions to identify the indicators. First, a scoping review of related studies identified a list of related indicators to the objectives of our research.[14] Second, we examined the existence of data associated with each indicator and the reliability of the data source, according to which many indicators were excluded. Finally, the included indicators were reviewed and approved by an expert panel, comprising of the research team plus selected key informants in the field of heath management, policy and economics. Our expert panel selected two categories including producing health indicators as dependent variables and contextual indicators as independent variables. Based on panel opinions, we choose producing health indicators that revealed the relationships of health

status and health coverage in countries based on the SDG_s.[15-18] Finally, five indicators were selected. For another category, we choose four indicators (Table 1).

The reasons for the selection of the contextual indicators were following as below:

- Two indicators of CHE and SHP are regarded as proxies of government obligation to health. Thus, showing a relationship between these two indicators and health indicators can show the governments' obligations to people's health and their health status.[11, 19-22]
- Population density indicator, as an independent context variable, (that is less controllable) is used to determine the relationship between population density and health status of a country.[23, 24]
- Health concerns are different according to values and philosophies of each country (that are displayed in Government type). To answer the question "Is the type of government related to health status of citizens?", we chose the "Government type" indicator.[25]

In summary, nine indicators were chosen as the main variables into two categories for this study. In the second step, regarding using secondary data in the study, we attempted to select valid data via various sources regarding the variety of indicators. The key element in choosing sources was the validity and reliability of the registered data, so that the assessments and comparisons of the study (on international levels) would be correct and close to reality. The data sources used for this study are listed in Table 1.

In the third step, we should identify the countries which had valid data in the selected indicators. Generally, 194 countries were candidate for further analysis based on availability of their data in the book "World Health Statistics Overview 2019". Initially, we intended to enter all the countries into the study, but a number of countries did not report data for the contextual variables; therefore, inevitably 25 countries were excluded regarding lack of valid data. Finally, 169 countries were included for investigating through the study. The research team used a checklist based on the study goals for data gathering. Meanwhile, for a clearer description of indicators, countries were categorized as follows:

1. Categories based on six regions of WHO: We categorized countries based on WHO regions including: Regional Office for Africa (AFRO), Regional Office for the Americas (AMRO), Regional Office for the Eastern Mediterranean (EMRO), Regional Office for Europe (EURO), Regional Office for South East Asia (SEARO), and Regional Office for the Western Pacific (WPRO) (see more details in Supplementary file)

2. Categories based on the income level averages: The 2019 SDG report categorizes countries according to their income groups including: High Income Countries (HICs), Upper-Middle Income Countries (UMICs), Lower-Middle Income Countries (LMICs), and Low-Income Countries (LICs). We calculated the geometric means of each indicator for income groups separately and then compared them with each other (see more details in Supplementary file).

Data Analysis

The relationships between variables were analyzed separately. We measured the correlations between each variable using Spearman Correlation. For measuring the correlation between dependent and independent variables, the correlation coefficient was used. The correlation coefficient is always a number between -1 to +1. A number between 0 and 1 means a positive correlation (the closer to 1 the stronger the correlation); positive correlation means that with increase in one variable, the other also increases. A number between 0 and -1 means a negative correlation (the closer to -1 the stronger the correlation); negative correlations means that with decrease in one variable, the other also decreases. The interpretation of this coefficient is as follows:[26]

- Coefficient between 0 and 0.29 shows a weak correlation
- Coefficient between 0.30 and 0.69 shows an average correlation
- Coefficient between 0.70 and 1 shows a strong correlation

Additionally, to analyze the relationship between producing the health indicators and government type,

Table 1: The variables of study

Indicators	Label	Source of data
Producing health indicators (Dependent variables)		SDG annual report 2019
Life expectancy at birth b,c (years)	LE	SDG annual report 2019
Healthy life expectancy at birth (years)	HLE	SDG annual report 2019
Maternal mortality ratio (per 100 000 live births)	Maternal mortality	SDG annual report 2019
Under-five mortality rate (per 1000 live births)	U5 mortality	SDG annual report 2019
Index of effective coverage of health services	UHC	SDG annual report 2019
Contextual Indicators (Independent variables)		
Current Health Expenditure[6] per Capita in PPP (in consent ppp)	CHE	Global Health Observatory (WHO)
Skilled health professionals density (per 10 000 population)	SHP	Global Health Observatory (WHO)
Population density (pop/km2)	Population density	World Bank (WB)
Government Type	Government	CIA fact book 2019

firstly the type of government of the countries were identified, and then analyzed by correlation test; lastly, they were demonstrated as scatter charts. We used SPSS 20 software for a descriptive analysis and R 2018 software for statistical analysis and also drawing of scatter charts.

Results

Descriptive Analysis

As mentioned in the methods section, due to high volume of data divided by countries, we present them in WHO's regional and income level categories. The highest and lowest LE were 84.2 and 53 years, respectively; African region countries (61.2 years) and also low-income countries (61.4 years) had the lowest average. The average of HLE rate was 63.3 years, which is 8.7 years less than the highest life expectancy. Countries in WPRO (68.9 years) and HICs (70.1) had the highest HLE (Table 2). Maternal mortality rate varies from 882 to 3 per 100000 live births globally (SD=6.8). AFRO countries (with 542 deaths per 100000) had the highest and EURO counties (with 16 deaths per 100000) had the lowest maternal mortality. The lowest mortality U5 mortality was 2.1 and the highest 127.3. The lowest to highest order for this rate in WHO regions were EURO, WPRO, PAHO, EMRO, SEARO, and AFRO. In the income level category of the countries, this rate increased according to the income level (Table 2).

UHC rates were highest in EURO countries (78%) and lowest in SEARO countries (44%) with an average of 64% (SD=14.2). In all producing health indicators, average status of the indicators improved along with increase in income in countries (Table 2).

The CHE average is $ 1564.2(SD=1816.7) and the highest numbers belonged to EURO region ($2879.8) and lowest to SEARO ($386). SHP, with an average of 61.3 per 1000 population (SD=53.9) was the highest in EURO (118.7 per 1000 population) and lowest in AFRO (13.7 per 1000 population). The average for population density in the world was 449.2 people per square kilometer (SD=2303.4); this indicator for AFRO (666.7 person in each square kilometer) was the highest and for PAHO (125.5 person in each square kilometer) was the lowest number (Table 2).

21 types of government were detected. Among 169 countries, most of them were govern by a "Presidential republic" system (59 countries), followed by "Parliamentary republic" system (35 countries) in the second and "Parliamentary democracy" system (15 countries) in the third place; with 8 countries with their own unique government types including governments led by communist party, constitutional federal republic, national confidence, constitutional monarchy of the federal parliament, federation of kingdoms, presidential and parliamentary elections, semi-presidential federation and single parliamentary republic (Figure 1).

Analytical Statistics

According to CHE with LE interactive distribution chart divided by WHO regions, the number of countries with high LE increases with an increase in CHE. Most of the PAHO countries are in the first quarter of the chart (low CHE, lower LE); this reveals that there can be exceptions in high CHE and low LE (and vice versa). The CHE with HLE interactive distribution chart also displays the same patterns and results.

Table 2: Descriptive statistics of the variables based on WHO regions and income level groups

Variables	Global				WHO regions						Income level groups			
	Global Average	Upper	Lower	SD	EMRO	AMRO	EURO	AFRO	SEARO	WPRO	HICs	UMICs	LMICs	LICs
Producing health Indicators (Dependent variables)														
Life expectancy	72.0	84.2	53	7.4	69.1	76.8	77.5	61.2	69.5	76.9	79.4	73.8	68.1	61.4
Healthy life expectancy	63.3	76.2	44.9	6.8	59.7	67.5	68.4	53.8	60.4	68.9	70.1	65.1	59.8	53.8
Maternal mortality	216	882.0	3.0	207.6	166	52	16	542	164	41	15.5	60.9	236.4	497.0
U5 mortality	40.8	127.3	2.1	28.9	51.7	14.2	9.6	76.5	38.9	12.9	6.3	18.6	44.6	77.6
UHC	64	79	29	14.2	64	53	78	73	44	55	75	73.2	67.4	53.7
Contextual Indicators (Independent variables)														
CHE	1564.2	10246.1	37.3	1816.7	1473.5	1535	2879.8	440.4	386	1348.6	3462.9	1008.4	422	115.5
SHP	61.3	271.6	1.6	53.9	44.5	44.9	118.7	13.7	32.4	63.9	108.5	59.6	25.7	9.6
Population density	449.2	21644.5	2.1	2303.4	276.2	125.5	531.4	666.7	387.9	469.6	697.5	158.2	117.9	1134.8

SD: Standard Deviation; WHO: World Health Organization; AFRO: Regional Office for Africa; AMRO: Regional Office for the Americas; EMRO: Regional Office for the Eastern Mediterranean; EURO: Regional Office for Europe; SEARO: Regional Office for South East Asia; WPRO: Regional Office for the Western Pacific; HICs: High Income Countries; UMICs: Upper-Middle Income Countries; LMICs: Lower-Middle Income Countries; LICs: Low-Income Countries; U5 mortality: Under-five mortality rate (per 1000 live births); UHC: Index of effective coverage of health services; CHE: Current Health Expenditure 6 per Capita in PPP (in consent ppp); SHP: Skilled health professionals density (per 10 000 population)

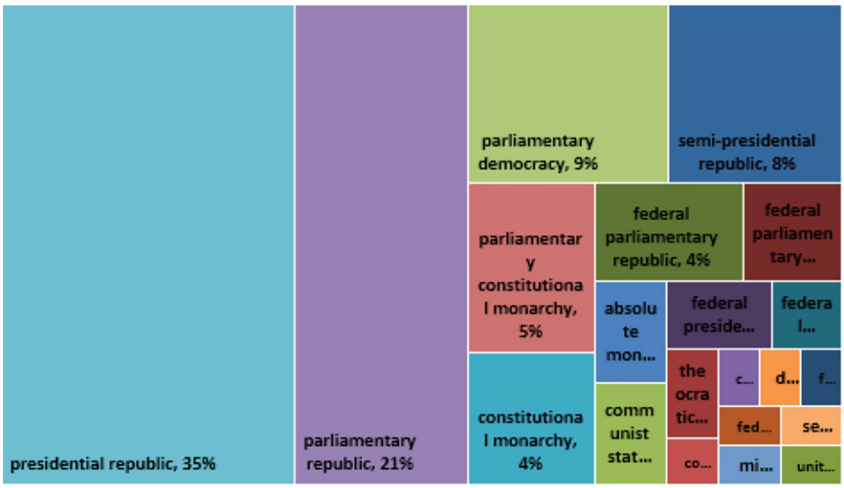

Figure 1: Descriptive statistics of "Government type" variable.

Furthermore, CHE with maternal mortality and U5 mortality rate interactive distribution chart shows that EURO countries are placed in the lower parts of the chart. According to distribution of CHE with UHC interactive distribution chart, UHC demonstrates a strong bond with CHE (Figure 2).

The scatter charts of SHP density with LE and also HLE show a positive relationship between these indicators; in other words, LE increases with an increase in SHP density. The relationship between SHP with maternal mortality and U5 mortality rate was inverse, indicating that (other than some exceptions) there's a weak relationship between SHP and mortality rates, so that mortality rates decrease with an increase in SHP density. On relations with UHC, there has been a strong and positive bond between SHP and UHC (Figure 3).

Scatter charts of population density with LE

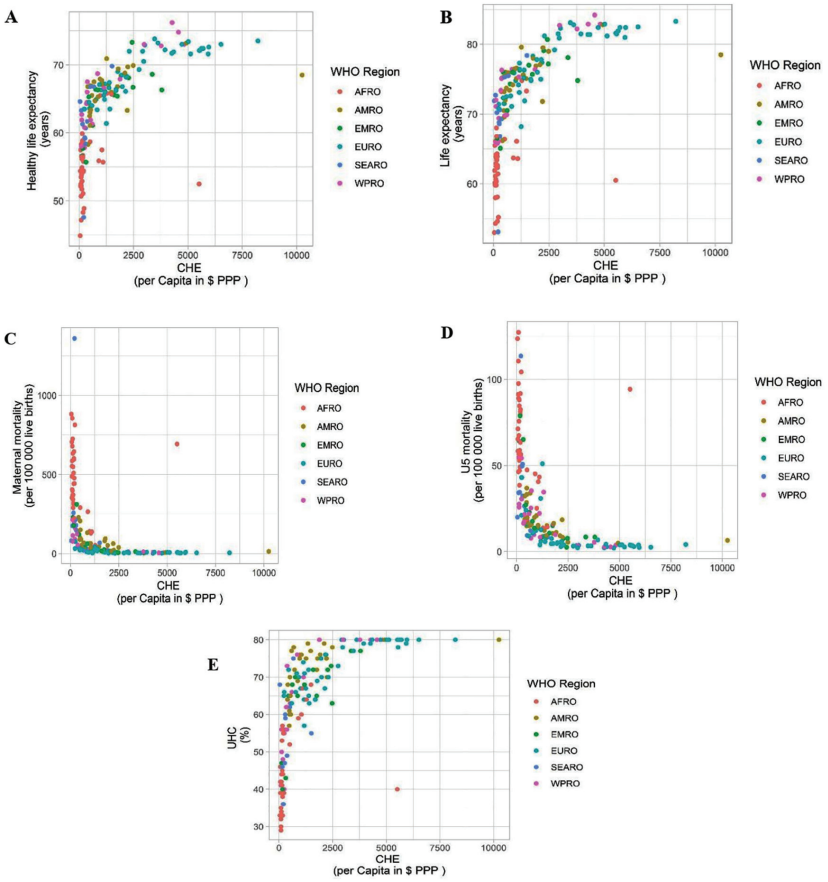

Figure 2: Distribution of CHE and producing health indicators based on WHO regions. WHO: World Health Organization; AFRO: Regional Office for Africa; AMRO: Regional Office for the Americas; EMRO: Regional Office for the Eastern Mediterranean; EURO: Regional Office for Europe; SEARO: Regional Office for South East Asia; WPRO: Regional Office for the Western Pacific; U5 mortality: Under-five mortality rate (per 1000 live births); UHC: Index of effective coverage of health services; CHE: Current Health Expenditure 6 per Capita in PPP (in consent ppp)

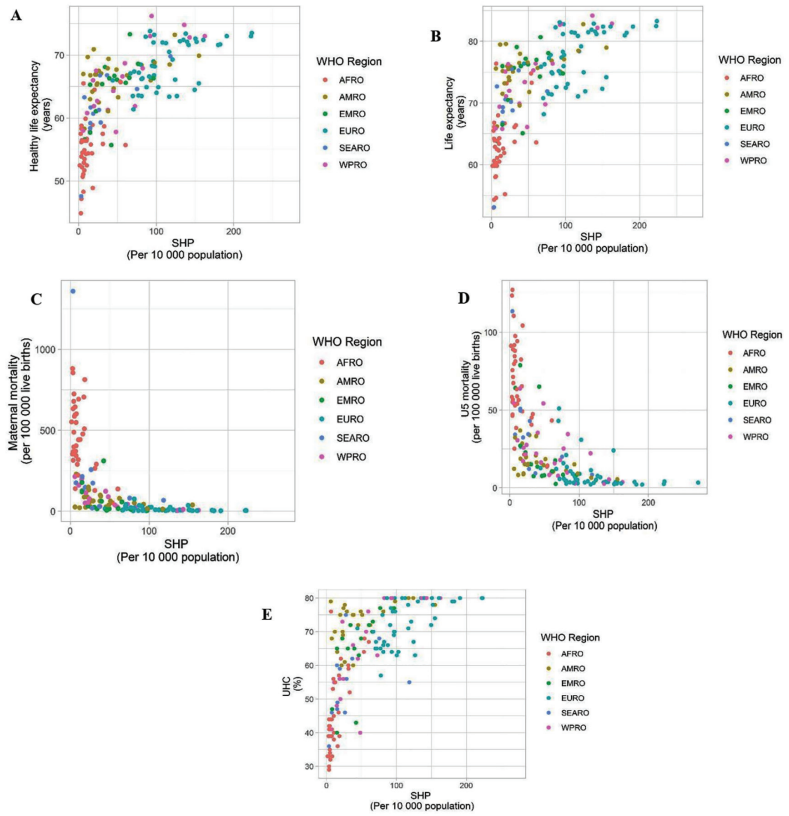

Figure 3: Distribution of SHP and producing health indicators based on WHO regions. WHO: World Health Organization; AFRO: Regional Office for Africa; AMRO: Regional Office for the Americas; EMRO: Regional Office for the Eastern Mediterranean; EURO: Regional Office for Europe; SEARO: Regional Office for South East Asia; WPRO: Regional Office for the Western Pacific; U5 mortality: Under-five mortality rate (per 1000 live births); UHC: Index of effective coverage of health services; SHP: Skilled health professionals density (per 10 000 population)

and HLE do not reveal a strong relationship, and the countries were highly scattered. In WHO region category, most countries were placed in the middle of the chart. In population density with maternal mortality and U5 mortality rate scatter charts, countries are mostly in the lower and middle parts of the chart with no strong relationships between population density and mortality rates. Results of population density with UHC indicators are similar to LE charts. Additionally, a lack of relationship between distribution of countries and variables is detected (Figure 4).

Based on the correlation test results, CHE indicator had a strong correlation with LE, HLE, and UHC indicators (r>0.7). Also, it has a strong negative correlation with maternal mortality and U5 mortality rate (r<-0.7). According to hypothesis significance test, the study hypothesis on the existence of a meaningful correlation between CHE and the producing health indicators is confirmed (P<0.05) (Table 3).

SHP has a strong correlation with LE, HLE, and UHC indicators (r>0.7) and a strong negative correlation with maternal mortality and U5 mortality rate (r<-0.7). According to hypothesis significance test, the study hypothesis on the existence of a meaningful correlation between SHP and the producing health indicators is confirmed (P<0.05) (Table 3).

According to the correlation test results, log population density has a weak correlation with LE, HLE, and UHC (r>0.2). This indicator has a weak negative correlation with maternal mortality and U5 mortality rate (r<-0.2). According to the hypothesis significance tests, the study hypothesis on the existence of the correlation between population density indicator and the producing health indicators, there is a small meaningful correlation between population density indicator and LE, HLE and U5 mortality rate indicators (P=0). Also, There's no correlation between the population density and maternal mortality rate and UHC (P>0.05) (Table 3).

On the interpretation of the relationship between government type and producing health indicators (Figure 4), it must be noted that the dependency range is from 0 to 1 (0 a dark orange and 1 a dark blue). For LE, HLE, and UHC indicators, due to being desirable indicators (meaning that an increase in the indicator means a better situation), the closer the number is to 1, there is more correlation between them and the analyzed indicators. Maternal mortality and U5 mortality, due to being undesirable indicators, the lower the indicator, the better the situation; the closer the number is to 0, there is more correlation between them and the analyzed indicators.

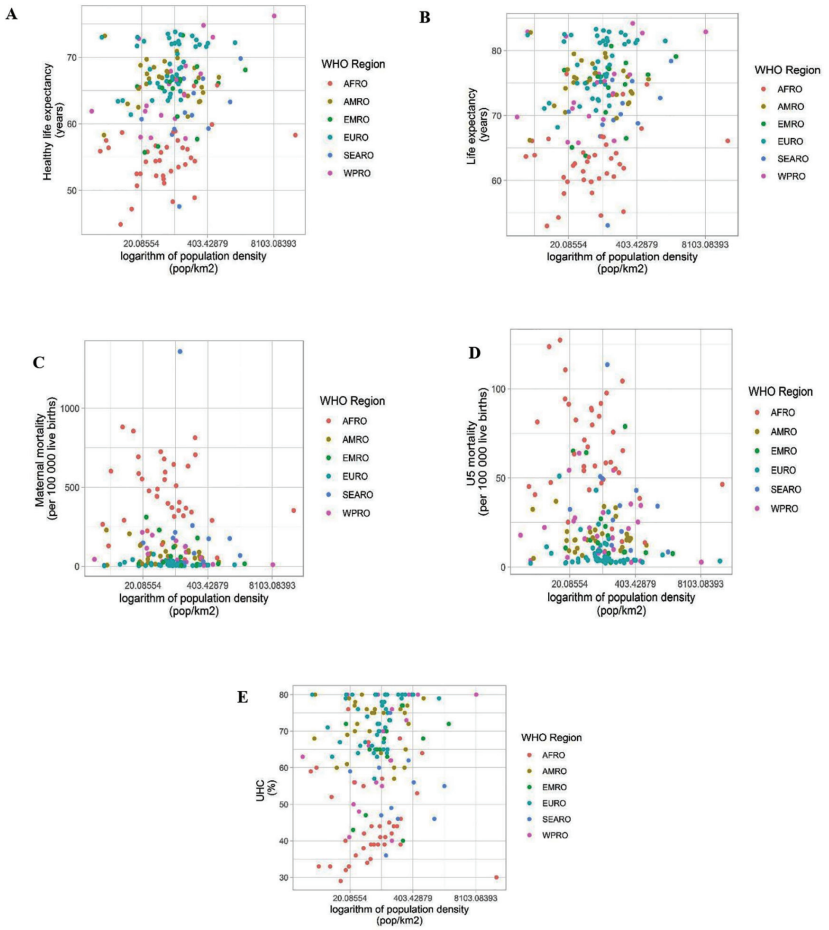

Figure 4: Distribution of Logarithm population density and producing health indicators based on WHO regions. WHO: World Health Organization; AFRO: Regional Office for Africa; AMRO: Regional Office for the Americas; EMRO: Regional Office for the Eastern Mediterranean; EURO: Regional Office for Europe; SEARO: Regional Office for South East Asia; WPRO: Regional Office for the Western Pacific; U5 mortality: Under-five mortality rate (per 1000 live births); UHC: Index of effective coverage of health services

Table 3: The relationship between dependent and independent variables

	Life expectancy		Healthy life expectancy		Maternal mortality		U5 mortality		UHC	
	Correlation	P value	Correlation	P value	Correlation	P value	Correlation	P value	Correlation	P value
CHE	0.86	0	0.85	0	-0.85	0	-0.87	0	0.85	0
SHP	0.76	0	0.78	0	-0.86	0	-0.83	0	0.78	0
Population Density (Log)	0.26	0	0.27	0	-0.21	0.01	-0.24	0	0.18	0.02

WHO: World Health Organization; AFRO: Regional Office for Africa; AMRO: Regional Office for the Americas; EMRO: Regional Office for the Eastern Mediterranean; EURO: Regional Office for Europe; SEARO: Regional Office for South East Asia; WPRO: Regional Office for the Western Pacific; U5 mortality: Under-five mortality rate (per 1000 live births); UHC: Index of effective coverage of health services; CHE: Current Health Expenditure 6 per Capita in PPP (in consent ppp); SHP: Skilled health professionals density (per 10 000 population)

According to the findings of this study, in countries with government types of "Federal parliamentary democracy" and "Single parliamentary republic", health indicators show a better status; meanwhile, in countries with "Semi-presidential republic", health indicators show a worse status (Figure 5).

Discussion

Results showed a considerable difference was observed between the averages of LE, HLE, maternal mortality, and U5 mortality rate across countries. Contextual variables like CHE, SHP, and population density had a significant relationship with producing health indicators. There are a few studies about the relationship between contextual variables of countries with health indicators. In these studies, similar to the findings of the current study, a meaningful and significant correlation was found between the amount of money that countries invest on people's health and health indicators, so that by investing more in health sector, an improvement in health indicators was seen.[26-29]

In the current study, a weak correlation was found between population density indicator with LE

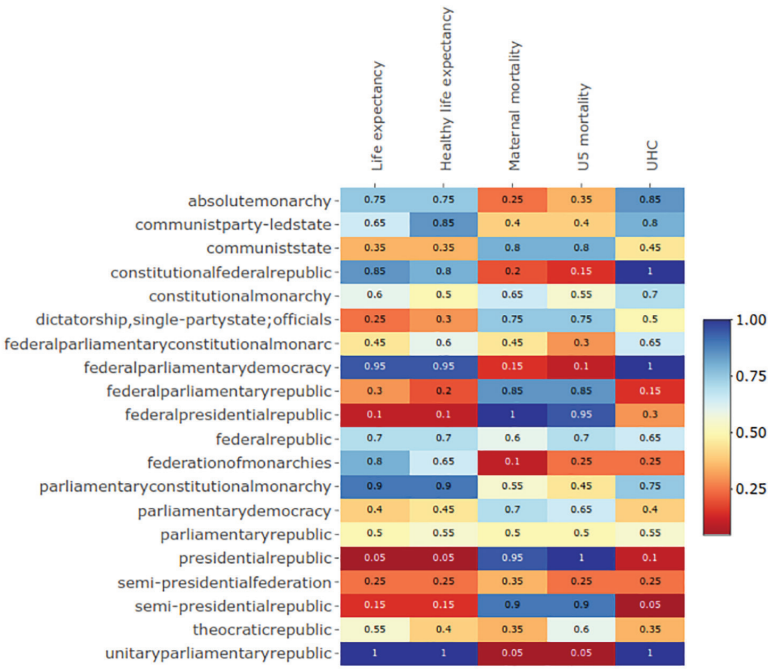

Figure 5: The relationship between "Governance type" and producing health indicators. U5 mortality: Under-five mortality rate (per 1000 live births); UHC: Index of effective coverage of health services

and HLE. There are few studies on the relationship between population density and health indicators. The results in a similar study conducted in Netherlands indicated that population density, on average, resulted in higher mortality rates.[30] Also, Beenackers et al. reported that generally higher population density was modestly related to increased mortality, while in dense cities with good infrastructure high population density may negatively impact the mortality.[31] In sum, it seems that more research is required about consequences of population density on health.

Another variable investigated was SHP density that was significantly correlated with LE and HALE. This positive correlation has been confirmed by another studies.[32] Clearly, based on the Millennium Development Goals (MDGs), the minimum level of SHP is estimated 2.5 health workers per 1,000 population.[33] In general, countries with higher GDP per capita and incomes have more health workers; for instance, the United States is among the countries with the highest income per capita and the greatest density of health workers per 1000 population, while most countries in sub-Saharan Africa have the lowest income per capita as well as the lowest health worker density.[28-30, 34] Therefore, increasing investment into main categories of health workforce can be an important strategy for improving health outcomes, especially in developing and undeveloped countries.

Further, there are few studies on the relationship of government types in countries and their health status. According to the findings of this study, countries with "Federal parliamentary democracy" and "Single parliamentary republic" have better situation in health indicators; furthermore, countries with "Semi-presidential republic" have worse health indicators compared to others. The considering dispersion in correlations of health indicators with government types can be due to the variety of government types. Meanwhile, since "Government type" is a qualitative variable, a better demonstration of its correlation with health status cannot be done.

A study carried out in global level on mapping 123 million neonatal, infant, and child deaths between 2000 and 2017 found that gains in child survival served as an important proxy for improvements in overall population health. Global progress in reducing child mortality has been declared as one of the greatest success stories of global health. The advances in child survival have been far from universally achieved, spatial in LMICs. They observed large subnational variation within countries in which overall U5-mortality was either high or comparatively low. Successful reductions in child mortality were also observed throughout entire countries.[35]

Measuring UHC in 204 countries showed that "globally, performance on the UHC effective coverage index improved from 45·8 (95% uncertainty interval 44·2–47·5) in 1990 to 60·3 (58·7–61·9) in 2019, yet country-level UHC effective coverage in 2019 still spanned from 95 or higher in Japan and Iceland to lower than 25 in Somalia and the Central African Republic". Based on this study, UHC effective coverage index in HICs and in AMRO and EURO is higher than others. The findings of this study confirm our results.[11]

"Global age-sex-specific fertility, mortality, HLE, and population estimates in 204 countries and

territories, 1950–2019: a comprehensive demographic analysis for the Global Burden of Disease Study 2019" is another study which has been done by Global Burden of Diseases (GBD). According to this study, global LE increased from 67·2 years in 2000 to 73·5 years in 2019. The total number of deaths increased from 50·7 million in 2000 to 56·5 million in 2019. Globally, HLE increased from 58·6 years in 2000 to 63·5 years in 2019. HLE increased in 202 out of 204 countries and territories in this duration. This study showed that LE in HICs and EURO was the highest and in AFRO was the lowest;[36] our study obtained the same results.

From long ago until now, the relationship between government type and health status has been taken into consideration. It is important how much countries value health. More progress will depend on greater strength in public sector rather than private sector which worsen the inequities.[37]

Conclusion

Overall, the results of a study confirmed a considerable difference between the countries in producing health indicators and also the relationship between contextual variables with producing health indicators across countries. There is a significant correlation between the CHE, population density, and SHP with health indicators, namely LE and HLE, maternal mortality, U5 mortality. Also, countries with "Federal parliamentary democracy" and "Single parliamentary republic" type of government have better status in health indicators. It seems contextual variables are a comprehensive health system approach that improves the health indicators.

Limitation

Dependent variables (e.g., LE, HLE) depend on not only three mentioned independent variables but also other factors. We just consider some important and measurable independent variables, so the present analysis is narrow in scope.

Highlights

There is a considerable difference between countries in producing health indicators.

There is a significant relationship between the density of SHP in the health sector and producing health indicators.

There is no significant relationship between population density and producing health indicators.

In countries where the government type is "Federal parliamentary democracy" as well as countries with a "Single parliamentary republic", health indicators show better conditions.

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Authors" Contribution

AR.O and AH.T were involved in the conception and designing the study. E.M and Zh.N performed literature review, data gathering and interpretation of data. M.M analyzed the data. AH.T and AR.O wrote the manuscript and acted as the corresponding authors. E.M and Zh.N supervised the development of work, and MM.K assisted in data interpretation and manuscript evaluation.

Ethical Approval

No ethical approval was required as all the data analyzed were publicly available.

Conflict of Interest: None declared.

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ORIGINAL ARTICLE

Evaluation of Bacterial Contamination in Sarein Mineral Spas

Behnam Afsar[1], MSc student;
Ebrahim Fataei[1], PhD;
Ali Akbar Imani[2], PhD

[1]Department of Environment, Ardabil Branch, Islamic Azad university, Ardabil, Iran
[2]Department of Agriculture, Ardabil Branch, Islamic Azad University, Ardabil, Iran

Correspondence:
Ebrahim Fataei, PhD;
Department of Environment, Ardabil Branch, Islamic Azad University, Ardabil, Iran
Tel: +98 9143549400
Email: eb.fataei@iau.ac.ir
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Abstract

Background: Failure to observe proper hygiene principles of water and swimming pool environment is effective in causing health problems and transmission of infectious diseases to swimmers. This study aimed to analyze the level of Escherichia coli and Heterotrophic Plate Count in mineral pools in Sarein.

Methods: For this purpose, sampling was performed in each season, and the samples were tested according to the standard method. Shapiro-Wilk and Kolmogorov-Smirnov test was used to determine the normality or abnormality of the data. Then, through ANOVA, the differences between the seasons and the pools were compared in terms of the studied parameters.

Results: The results of the analysis of variance showed that there was no significant difference between the spas in terms of the measured parameters. A comparison of the average data showed that the amount of contamination of mineral spas during the seasons with E. coli was more than the allowable value announced by the National Standard Organization of Iran. The amount of residual chlorine in all samples was zero and the pH was equal to 6.8. The results of principal component analysis showed that mineral spas No. 6, 2, and 11 had the highest HPC (Heterotrophic Plate count) and pH and 9 Cheshmeh, Ershad, and Ghahveh Sui mineral spas based on the second component had the highest E. coli; No. 7 had the lowest E. coli.

Conclusion: Finally, it can be concluded that the cause of the contamination of mineral swimming pools in Sarein city is the high volume of passengers and the lack of proper sanitary management of swimming pools.

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Introduction

Geothermal resources provide a stable warm environment, which is the preferred condition for thermophiles. The composition and properties of hot spring water may vary in terms of organic and mineral chemical elements, pH and nutrients, which may provide favorable conditions for microbial biodiversity.[1-3] Geothermal water is currently used only for recreational purposes in swimming pools.[4] In natural swimming pools, chemical disinfection replaces natural biological processes for water treatment.[5] Despite the growing popularity of these natural systems, little is known about the effectiveness of natural processes in eliminating intestinal pathogens in swimmers. It is also well known by health officials that most recreational illnesses are not recognized in regular health care programs,[6] so the majority are not reported.[7] In general, the chlorine-resistant parasitic protozoan, Cryptosporidium hominis, is the leading cause of gastroenteritis in swimming pools which is caused by fecal diffusion.[8-12]

Human feces may contain pathogens[13-16] and is a known route of infection in recreational aquatic environments.[17-20] Hence, in a natural pool with no

chemical disinfectant residues, pathogens persist until the pool water containing human intestinal viruses, which are the most numerous and most infectious of these intestinal pathogens, cross sufficient natural barriers.[21-24] It should be noted that many pollutants such as other microorganisms and nutrient compounds can be present in aquatic environments naturally or due to human activity.[25-31] Also, mineral and natural compounds or different toxic compounds can be found in the hot water mediums.[32-37]

Sarein city in Ardabil province is very popular due to the existence of numerous geothermal hot springs with a temperature of 45 degrees Celsius. These springs are heated by an inactive volcano in the second highest mountain of Iran, Sabalan.[38] Several researchers have studied the biological contamination of Sarein hot mineral water pools. The study of Sadeghi et al.[39] which aimed to evaluate the quality of mineral spas in Sarein tourist city in Ardabil province showed that, in general, during 5 months of sampling of mineral spas, only 18.82% of the samples were in the standard range compared to the allowable limit of Staphylococcus aureus. Therefore, 81.18% pollution in mineral spas of Sarein city has a risk of skin diseases and possible infections for swimmers. Feyzolahpour et al.[40] observed that due to complete disinfection of pools with chlorine, no dermatophytes were found in Sarein mineral spa. In the study of Seyedmousavi et al.,[41] Aspergillus fumigatus with 22.79%, Aspergillus feldous with 15.54%, Aspergillus niger with 15.54%, and Penicillium with 14.5% had the highest frequency of isolated fungi, respectively. Also, each of the fungi of Ulocladium, Sepdonium, Acromonium, Psilomasis, Stemphylium and Streptomyces with a positive plate of 0.51% had the lowest frequency. In their study, no dermatophyte fungi were isolated from carpet and water samples. Also, no real dimorphic pathogen was isolated in their study. The absence of dermatophyte pathogenic fungi and fungi causing superficial and cutaneous fungal diseases showed that training workers, continuous washing and disinfection of swimming pools, and observance of hygienic standards have been effective in reducing pollution; on the other hand, hot mineral water can prevent the growth of pathogenic fungi. Therefore, it is necessary to conduct various studies on the biological contamination of hot mineral water pools at specific intervals to prevent the occurrence of health consequences due to biological contamination of these pools. Therefore, in this study, the biological pollution of mineral spas in Sarein city was investigated.

Methods

This is a descriptive-analytical study that was conducted during 2019 to determine the microbial quality in the water of Sarein mineral pools. In this study, samples were randomly taken from 13 pools in Sarein, including mineral pools with codes 1 to 13.

Steps of Microbial Water Testing

1. Possible stage: In this stage, we use broth lactose culture medium with two weak and strong dilutions, so that we put three tubes of strong lactose broth and six tubes of weak lactose broth in one tube, respectively. In the first three tubes where lactose broth is strong, we add 10cc of water; in the second three tubes where lactose broth is weak, we add 1cc, and in the third three tubes, which are also weak lactose broth, we add 0.1cc of the sample. Then, we add water. The tubes are then shaken and placed in an incubator at 35.5-37 degrees for 24-48 hours. At this stage, the possibility of bacteria is checked and reported with the MPN unit per 100 ml.

2. Confirmation stage: In this stage, the culture medium of brilliant green and EC broth is used. Thus, from the positive samples of the first stage (carbonated tubes), we transfer the lactose broth culture medium to these two media. We place the diamond tube inside the incubator and the EC broth inside the 44.5-degree pan. We review the results after 24 hours. If both tubes are negative, it means that there is no problem with water, and the first stage that was positive was bacteria other than coliforms, and the water is drinkable; yet, if the brilliant tube is positive and the EC tube is negative, the water has coliforms and the amount of MPN is reported. It is possible, but, in terms of fecal form, (E. coli) if it is negative and the water is chlorinated, it is drinkable. If both diamond and EC pipes are positive, as well as the coliform, the water also has E.coli and is not drinkable.

Analysis

This is an analytical-descriptive study. The statistical population included 13 active swimming pools in Sarein city, including codes 1 to 13, which were examined for 1 year in each season. In this study, sampling was performed from each pool in the required number each month according to the standard conditions and was transferred to the reference laboratory of Ardabil University of Medical Sciences for analysis. E. coli bacteria[10] were measured in the laboratory. The diagnosis method of E. coli was 15 tubes and the use of lactose broth and EC media.

The results of microbial tests were recorded in Excel, and SPSS software[42, 43] was used for statistical analysis of data. MINITAB15 software was used to draw the cluster analysis and principal components analysis. The Shapiro Wilk and Kolmogorov-Smirnov tests were used to determine whether the data were normal or abnormal. Then, through ANOVA,[44] the differences between the seasons and the pools were compared in terms of the studied parameters. T-test

was used to compare the data with the national standard of Iran.

Results

Before performing statistical analyses, Shapiro-Wilk and Klemgorov-Smirov (K-S) tests were performed to evaluate the normality of data distribution in the studied variables. The results showed that the studied variables had a normal distribution (sig> 0.05). Therefore, the results of analysis of variance, T-test, cluster analysis and PCA were interpreted and analyzed using statistical methods of data analysis.

Analysis of Variance and Comparison of Mean Data

For the data obtained from the measurement of the studied parameters in 13 spa pools of Sarein city, analysis of variance was performed by considering monthly sampling periods as replication and types of spas as treatment using SPSS software. The results of analysis of variance (Table 1) for pH, HPC (Heterotrophic Plate count), and E. coli parameters that were measured in 13 spas and in different time periods showed that there was no significant difference between the spas in terms of the parameters measured. However, to ensure the evaluation of the water quality of the spas in terms of the parameters measured and to complete the information about each parameter separately for the spas, the average with the data was checked.

The results showed that there was no significant difference in pH between mineral water samples. Samples No. 7, 4, and 10 had the highest amount of E. coli and sample No. 13 had the lowest amount of E. coli. Also, in terms of HPC, the highest amount was related to waters No. 11, 2, 6 and 1 and the lowest to number 13.

T-test Statistical Test Results

T-test was performed to know the microbial status of mineral spas in Sarein by comparing the measured values of E. coli and HPC parameters with the national standard values of Iran for hot mineral waters (Table 2). The values of Iran national standards for hot mineral waters are presented in Table 2.

High levels of E. coli in pools No. 1, 2, 4, 6, 7, 8, and 11 (Royal Park, 9 Cheshmeh, Iranian, Ghahveh Sui, General, Sabalan, Ershad) in different seasons of the year were more than the allowance of the National Standard Organization of Iran due to the lack of using showers by swimmers at the entrance or exit of these spas in Sarein. Also, the levels of HPC in pools 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, and 12 in different seasons of the year were more than the allowable limit of the National Standard Organization of Iran due to lack of timely water change of swimming pools and not washing the walls and floors of swimming pools in Sarein city.

Cluster Analysis

Cluster analysis is one of the multivariate analysis methods that aims to group the studied spas based on their qualitative characteristics so that spas with similar quality characteristics are in a group. According to the predetermined criteria, grouping will be appropriate when the stations within the groups have more homogeneity and are more heterogeneous between the groups. Investigating the relationship between 3 parameters in 13 spas for the measured parameters requires the analysis of 13×3 correlation matrix. On the other hand, it is necessary to check the condition of the spas and the amount of their pollution by considering all the parameters. Therefore, due to the large volume of data, clustering parameters and spas were performed using cluster analysis based on dissimilarity matrices. Minitab22 software was used for this purpose. To perform cluster analysis, we used the input method based on the minimum square of Euclidean distance after standardizing the data. The average sampling periods for each parameter were used to classify the measured quality parameters in the studied spas of Sarein city and determine their microbial contamination status. Dendrogram section based on the farthest Euclidean distance divided hot waters into four groups. Figure 1 shows the dendrogram of Sarein spas clusters analysis based on the measured parameters.

The first group (first cluster) included No. 1 Royal Park Spa. This spa pool was higher than the average of the measured values in terms of pH and HPC parameterS (Table 3), and the quality changes

Table 1: Mean squares obtained from analysis of variance of measured parameters in hot springs of Sarein city in 2019

Sources of change	pH			E. coli			HPC (Heterotrophic Plate count)		
	Sig.	F	MS	Sig.	F	MS	Sig.	F	MS
Stations (intergroup)	0.34	1.9	207181.2	0.133	1.473	0.004	0.753	0.968	921.679
Error (within group)	-	-	109025.4	-	-	0.003	-	-	1320.638

**, * and ns: Show significance at 1% probability level, significance at 5% probability level and non-significance, respectively.

Table 2: National Standards of Iranfor mineral pools

Type of microorganism	Allowable number of bacteria
Heterotrophic bacteria	200 per milliliter
E. coli or thermophilic coliforms	Less than 2 per 100 ml

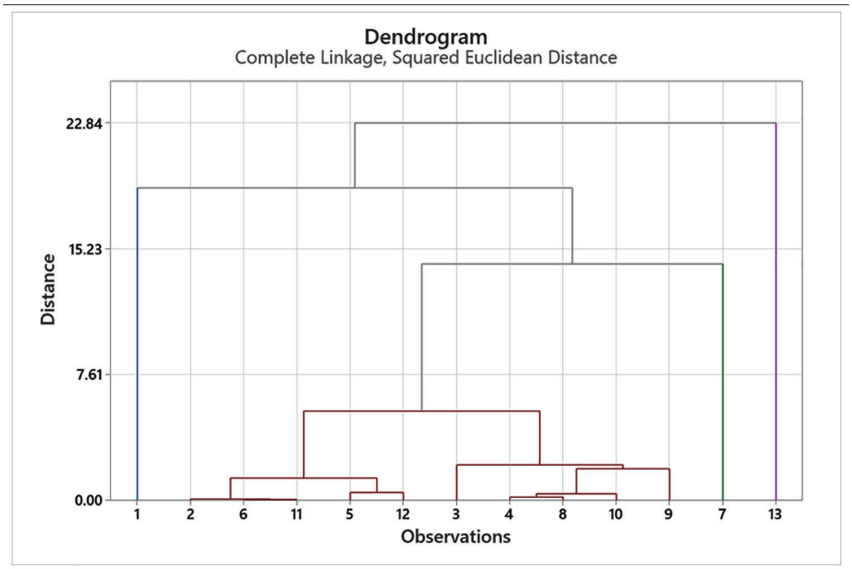

Figure 1: Dendrogram obtained from the cluster analysis of the studied spa based on PC1 (Principle Component) and PC2 (Principle Component) values for the parameters measured in Sarein

Table 3: Mean deviation from total mean and standard deviation of means in 3 clusters obtained from cluster analysis for the evaluated parameters

Cluster	E. coli	pH.	Statistical parameter
1	7.2414	6.8414	$\bar{x}$
2	5.5498	6.8010	$\bar{x}$
3	23.1739	6.8	$\bar{x}$
4	0.00	6.8	$\bar{x}$
Average	6.6087	6.804	Total

* and **: Show significance between clusters at 5% and 1% probability levels, respectively.

of this spa were mainly due to the high volume of customer reception and lack of timely change of pool water and washing of the pool area. The second group (second cluster) including the spas No. 10, 8, 4, 3, 12, 5, 11, 6, 2, and 9 were ranked second in terms of HPC parameter. E. coli and pH were also lower. Changes in these spas are mainly due to non-compliance with health protocols, failure to change the water of swimming pools in a timely manner, and the swimmers' failure to shower before entering the swimming pools. The quality of 9 Cheshmeh, Ghahveh Sui, and Ershad spas is due to the provision of part of the pool water by Pahnloo spring, high number of the swimmer's visit to the swimming pool, non-timely change of swimming pool water, washing and disinfection of the pool area and the swimmers' shower before entering the swimming pool; also, the quality of spas No. 5 and 12 (Darreh Lor Sui and Bash Bajilar) is due to the provision of part of the swimming pool water by Pahnloo spring, the high number of the swimmer's visit to the swimming pool, failure to changing the swimming pool water in time, washing and disinfection of the pool area, the swimmers' shower before entering the pool. Moreover, the quality of Sari Sui spa is due to not changing the water of the swimming pools in time, washing and disinfecting the pool area, the swimmers' shower before entering the pool; also, the quality of Sabalan spa is due to providing part of the pool water from Gavmish Goli, the high number of the swimmers visiting the swimming pool, not changing the water of the swimming pool in time, washing and disinfecting the inside of the pool and swimmers' shower before entering the pool. The quality of the Iranian spa is due to the supply of part of the pool water from Gavmish Goli, high number of the swimmer's visit to the swimming pool, lack of timely change of swimming pool water, washing and disinfection of the pool area and swimmers' shower before entering the pool and the quality of Aftab city spa is due to providing part of the pool water from Pahnloo spring, high volume of swimmer visits to the swimming pool, failure to change the swimming pool water in time, washing and disinfection of the pool area and swimmers' shower before entering the pool; finally, the quality of Gavmish Goli spa is due to the high number of swimmers visiting the swimming pool, not changing the water of the swimming pools in time, washing and disinfecting the pool area and swimmers' shower before entering the pool. As to the third group (third cluster) in which General spa was placed alone in the group, its quality is almost average, which is due to the timely change of water in swimming pools, washing and disinfection of the interior part of the pool and the swimmers' shower before entering the pool. As to the fourth group (fourth cluster) in which

Viladragh spa was placed alone, its quality is desirable due to the low volume of the swimmer's visit to the swimming pool, timely change of swimming pool water, washing and disinfection of the pool area and taking a shower before entering the pool. Therefore, in general, it can be stated that Royal Park Mineral Spa No. 1 has a higher pH and HPC. The General Spa No. 7 has the lowest amount of E. coli, and Viladragh Spa No. 13 is desirable in terms of all parameters. After that, the second group with Moderate pollution (MP) included Gavmish Goli, Sabalan, Iranian, Shahr Aftab, Bash Bajilar, Darreh Lor Sui, Ershad, Ghahveh Sui, 9 Cheshmeh, and Sari Sui spas; the rest of the stations are in the Low pollution group (LP). The results of one-way analysis of variance confirmed the existence of significant differences between the groups in terms of most of the studied parameters at the probability level of 1% and 5%. Examination of the differences between the groups showed that the spas within each cluster did not differ significantly in terms of the measured parameters. However, there was a significant difference between the clusters in terms of most of the evaluated characteristics at the probability levels of 1% and 5% (Table 3).

Results of PCA

The results of PCA (Principle Component Analysis) showed that of the three main components, the first two components explained more than 71% of the changes, so that in the formation of the first component, HPC, and pH had the highest positive effect and in the second component, E. coli had the most positive effect. Therefore, mineral spas No. 6, 2, and 11 (Ghahveh Sui, 9 Cheshmeh and Ershad) had the highest HPC and pH and 9 Cheshmeh, Ershad and Ghahveh Sui mineral spas, based on the second component, had the highest E. coli; also, General mineral spa No. 7 had the lowest E. coli.

The eigenvectors and eigenvalues of the parameters in the PCA (Principle Component Analysis) are presented in Tables 4 and 5, respectively.

Discussion

Based on the results of this study, there was no significant difference between the spas in terms of the measured pH and E. coli parameters. From a public health perspective, frequent measurement of disinfectant concentrations and pH is a very effective way to control water quality.[45] The pH of mineral waters does not differ significantly. However, in the study of Yazdanbakhsh et al.,[46] different pools had different pH levels, which was statistically significant. The water No. 7, 4, and 10 had the highest amount of E. coli, and the water with code 13 had the lowest amount of E. coli. As to the mean data of E. coli parameter in spa pools No. 2 and 12 (9 Cheshmeh and Bash Bajilar) with the national standard of Iran for mineral spa pools, there was a significant difference in terms of E. coli at 99% probability level. High levels of E. coli in swimming pools No. 1, 2, 4, 6, 7, 8, and 11 (Royal Park, 9 Cheshmeh, Iranian, Ghahveh Sui, General, Sabalan, Ershad) in different seasons of the year were more than the allowed limit by the National Standard Organization of Iran, due to the lack of use of showers by swimmers at the entrance or exit of these spas in Sarein. In a study by Masoud et al.,[47] the presence of E. coli in pool water showed fecal matter from contaminated skin or fecal matter which entered the pool water accidentally. It was also found that the treatment process could not remove this contamination. In their study, E. coli was the most consistent index and was isolated from 7 out of 120 samples. Similar results have been reported by Leoni et al.[48] In their study, only 2.6% of the samples showed positive results. Abd El-Salam[49] also reported that E. coli was not found despite the low concentration of chlorine in most samples. This may be attributed to the relatively small sample size because only 30 water samples were examined in their study.

Conclusion

In this study, multivariate statistical methods of analysis of variance, T-test, cluster analysis, and PCA (Principle Component analysis) were used to determine the quality of spas in the tourist city of Sarein in terms of microbial parameters of E. coli, HPC, and alkalinity. The two-dimensional display of the stations based on the first two main components confirmed the grouping of the results obtained from the cluster analysis as well as the principal components analysis; thus, the studied spas were separated in terms of microbial contamination status as cluster analysis. Using cluster analysis method, we categorized 13 sampling stations into four clusters with

Table 4: The eigenvectors of parameters

Variable	PC1 (Principle Component)	PC2 (Principle Component)	PC3 (Principle Component)
pH	0.595	-0.552	-0.584
E. coli	-0.293	-0.826	0.482
HPC	0.749	0.115	0.653

Table 5: The eigenvalues of parameters

Eigenvalue	1.1189	1.0388	0.8423
Proportion	0.373	0.346	0.281
Cumulative	0.373	0.719	1.000

similar quality characteristics. In order to determine the effective parameters in microbial contamination of spas in the tourist city of Sarein, we performed PCA (Principle Component analysis) in four different qualitative groups. The first two main components of PCA (Principle Component analysis) revealed that the major parameters responsible for changes in the microbial quality of spas in Sarein were E. coli and HPC. Also, the amount of HPC and E. coli bacteria in the swimming pools of Sarein city in different seasons of the year were higher than the national standard of Iran.

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Authors' Contribution

Conceptualization: Behnam Afsar. Data curating: Behnam Afsar. Formal analysis: Ali Akbar Imani. Investigation: Behnam Afsar. Methodology: Ebrahim Fataei. Project administration: Ebrahim Fataei. Resources: Behnam Afsar. Software: Ali Akbar Imani. Supervision Ebrahim Fataei. Validation: Ali Akbar Imani. Visualization: Ebrahim Fataei. Writing–original draft: Behnam Afsar. Writing–review & editing: Ebrahim Fataei

Ethical Approval

There was no need for ethical considerations in conducting this study.

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ORIGINAL ARTICLE

Unit Cost Calculation of CT Scan Services based on Step-Down Method: A Case Study of Iran

Kaveh Houman[1], MSc;
Alireza Ghorbani[2], PhD;
Behrouz Fathi[3], PhD;
Bahram Nabilou[3], PhD;
Hasan Yusefzadeh[3], PhD

Abstract

Background: CT-scan is one of the radiology units in which various services are carried out by injection and without injection to describe the patient's anatomy better. Given the increasing costs of the CT due to diagnostic equipment, it is necessary to calculate the exact costs of services provided to determine optimal pricing and logical tariff of these services.

Methods: The present study is an applied and cross-sectional research performed by step-down costing method using the data of 2018 at the CT-scan unit of the radiology department of Imam Reza Hospital in Urmia. In this study, standard forms related to direct and indirect costs of CT units and other activity centers have been used to collect the data. Appropriate sharing bases were used to determine the share of the costs of other departments in the services of this unit.

Results: The cost of a brain scan without injection was calculated 66.7$PPP, the brain with injection 143.9$, the chest without injection 84.4$PPP, the chest with injection 163.5$PPP, upper and lower limbs without injection 150.1$PPP, spine (cervical, thoracic, lumbar) 135.6$PPP, abdomen and pelvis without injection 149.2$PPP, abdomen and pelvis with injection 243.9$PPP, sinus 94.1$PPP, carotid CT angiography (extracranial) 287.5$PPP, and thoracic aortic CT angiography 277.8$PPP.

Conclusion: The study results showed a significant difference between the actual price of CT scan services and tariffs. Also, the shorter the service time and the more services in the CT scan department, the lower the unit cost. Comparing the cost of selected CT services in this study, we found that some time-consuming services, which were mainly related to injection services, imposed higher costs on the centers.

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[1]Social Security Organization, Urmia, Iran
[2]Department of Public Health, School of Health, Sabzevar University of Medical Sciences, Sabzevar, Iran
[3]Department of Health Economics and Management, School of Public Health, Urmia University of Medical Sciences, Urmia, Iran

Correspondence:
Hasan Yusefzadeh, PhD;
Department of Health Economics and Management, School of Health, Sero Street, Nazloo Paradise, Postal Code: 57561-15198, Urmia, Iran
Tel: +98 44 32752300
Email: yousefzadeh.h@umsu.ac.ir
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Introduction

The radiology department is one of the paraclinical departments of hospitals, where various services are performed, including Computed tomography (CT), radiography, Magnetic Resonance Imaging (MRI), and sonography.[1] CT is one of the radiology units where multiple services are performed with and without injection to better describe the patient's anatomy.[2] In addition, advanced diagnostic equipment is used in the radiology department, and more than 80% of hospital clients require radiology services.[3] Consequently, it would be the costly hospital unit which accounts for a large share of hospital costs.[4]

Increased hospital costs made managers and health policymakers in all countries find new ways to control the costs to use services more efficiently while maintaining the quality of services with fewer resources and, therefore, lower costs.[5, 6] Cost analysis is a management tool that can help managers access the data needed to make more informed investment decisions about actions and infrastructures.[7] Cost analysis can help ward managers, heads, and hospitals authorities and policymakers determine whether costs are higher than the total revenue and subsidies available. They provide operational performance information centered on cost issues. Comparing this information with the expected budgeted function can help identify the problems that need immediate attention, intervention, and corrective actions.[8, 9]

At present, to use financial resources more efficiently and effectively, cost management systems are increasingly used.[10, 11] One of the new methods with growing applications in day-to-day service activities is the step-down method. In this method, a network is designed for hospital units, which are considered as a network. First, the overhead units, central units (diagnostic), and final units (patient care) are listed. General and overhead service units and intermediate service units are indirect services, and the last service units are direct service units. This system uses appropriate methods to estimate the effects of changes in activities, complexity, diversity, and specific characteristics of each activity in calculating its costs.[12] This method relates costs to actions based on the number of resources used and then allocates them to cost purposes based on the number of activities.[13-16]

In a study conducted to calculate the cost of radiology services in educational and medical hospitals in Ahvaz, the costs attributed to radiology services were estimated at $1727627.1, with the largest share (3.43%) of costs related to workforce costs. The present study showed that accurate methods of calculating costs, such as activity-based costing, should be used for pricing services.[14] Another study conducted in Shafa Hospital of Kerman based on the activity-based costing method showed that personnel costs with $231837.8 PPP account for 7.55% of the total cost, which has the highest share in the costs of the ward. In addition, 68.97% of the department total expenses are related to direct costs, and $9662.5 (32.2%) are associated with indirect costs.[15] Therefore, due to the increasing costs of the radiology department, including the CT unit due to the use of advanced diagnostic equipment and devices, the cost of services provided are calculated and accurately determined by a step-by-step method to estimate the actual cost to help budget the hospital. It is necessary to prevent waste of resources and control costs, and shift services to the private sector. Given the importance of the issue for the health policymakers and managers of the Social Security Organization and the economic problems and high costs of CT services, it seemed necessary to calculate the cost precisely. This study used a step-by-step reduction method to analyze and estimate the unit cost of CT services at Imam Reza hospital in Urmia, aiming to determine optimal pricing and rational tariffs for the services.

Methods

This is an applied descriptive-analytical study using descending reduction costing and the data of 2018 in the CT unit of the radiology department of Imam Reza Hospital in Urmia. Researchers' standard forms through national and international studies have been used to collect the data in the present study. Data collection checklists in this study have been used in various domestic and foreign studies. Experts have confirmed its validity in this field, and the double-check method was used to check its reliability. The obtained data were analyzed using a step-down method and economic and accounting techniques of cost calculation in the following steps.

Step 1: Activity Centers Definition

Activity centers cause direct costs in the center of activity and attract indirect costs from other activity centers. Observation and interview techniques were used to identify the hospital centers of activity. CT-scan centers, radiology, facilities, administrative and financial, pantry, etc., were recognized and identified in this stage.

Step 2: Separation of Activity Centers According to Operations

Activity centers were divided into three general categories according to the procedures they perform:

1. Operational Activity centers: These are the wards that are directly involved in the process of providing services to patients. According to the purpose of this study, the radiology department was selected as the center of operational activity.

2. Output-Based Activity Centers: These activity centers operate to provide diagnostic and additional services to operating departments and patients and can also be considered independent cost units. In this study, units such as pharmacies were selected as the center of output-oriented activity.

3. General Support Activity Centers: These centers provide public service and support activities for operational and diagnostic activity centers and are not directly involved in providing the patients with services. In this study, units such as accounting, warehousing and logistics, security, butler's pantry, facilities, office and finance, telephone house,

self-service and kitchen, cleaning and housekeeping, and urban facilities were selected as support activities centers.

Step 3: Determining the Output of Each Activity Center

After identifying the activity centers, we determined the outputs for each activity center. That is, the type of output of each activity center was determined at this stage. The activity centers defined outputs in the "number of scans taken" in diagnostic processes. Due to the nature of their tasks and performance, these units do not have a specific output; rather, all activities of these units are in line with providing services to operational and diagnostic departments.

Step 4: Costing Operations Based on Each Activity Center

Costs in each activity center are divided into two general groups: direct and indirect costs. The direct costs of the radiology department include:

Cost of Workforce

The cost of the workforce in this center of activity includes the costs of salaries, overtime, productivity, and all the benefits that the hospital pays to the radiology department staff. Besides, all auxiliary costs such as insurance, taxes, etc., imposed on the hospital are part of the workforce cost.

Cost of Materials and Consumables

In this stage, material and consumables costs are divided into two general categories: direct and indirect material costs. Direct material costs are those used to provide services in this center of activity. Indirect costs, such as the cost of film used for radiology operations, include the costs unrelated to the provided services to each patient. Still, they are more commonly used for the general activities in the center, such as office supplies or costs related to the nutrition of the staff working in the hospital radiology department.

Depreciation Costs

Depreciation costs replace the existing property and equipment, calculated according to their use and shelf life. The direct depreciation method will determine the annual depreciation cost each asset according to the current equipment price and their shelf life. To determine the annual depreciation cost of the building, considering the base price per square meter and valuable life (which is considered a maximum of 50 years), we finally calculated the share of CT unit from the radiology department based on the space occupied by each activity center.

Step 5: Attributing the Costs of Each Activity Center to the Final Cost Centers

At this stage, the costs of different centers are allocated to the radiology activity center. In this study, the criterion or basis for sharing general expenses and support for the intermediate and final wards is the number of staff working in the wards, number of consumables and the area of the unit; the criterion for allocating the cost of the middle wards to the radiology department is the number of photographs.

Step 6: Calculating the Cost in Terms of Each Output

For calculating the cost of each production (including CT and MRI services), the total costs allocated to the radiology department were divided by the number of defined outcomes of this department. Thus, the cost of CT and MRI services were obtained separately.

Data Analysis Method

The present study is an applied and cross-sectional study. The data were collected through observation, interviews, and completing the forms designed. To determine the indirect costs, we identified the sub-activity centers that provide services to the CT unit of the radiology department. By estimating the share of the costs of other units in the provision of the services of the CT unit, appropriate sharing bases were determined, and indirect costs were calculated using these bases. To calculate the exact cost of each service, we estimated the average time required to perform a service. By summing up the direct and indirect costs shared by other departments, the cost of the selected CT unit services was determined using step-down method and Excel software. The cost price was estimated. In addition, all the costs were calculated based on Purchasing Power Parity (PPP) 2018, adjusted by an equivalent of ????

Results

In the CT unit of Imam Reza Hospital in Urmia, the share of general costs (water, electricity, gas, telephone) was $209.6. The overhead costs (support) were $339027.9, and the personnel costs were $882671.6. The cost of annual maintenance and repairs of equipment was $43852.2. In addition, the cost of consumables was calculated $7975.3 (Table 1). The depreciation cost of CT equipment was $36977, and that of building was $23410.2.

Table 1: Cost share of the computed tomography unit separately (percent)

Share of maintenance and repair costs	3.39
Share of consumables costs	0.62
Share of general costs	1.62
Share of overhead costs	26.19
Share of personnel costs	68.19

The total costs of the CT unit disregarding the depreciation of equipment were $1294489.2, and the total costs in this unit without considering the depreciation of equipment were $1664261.4. Also, the total costs of the CT unit with and without taking into account the depreciation cost of the building were $1664261.4 and $1687671.6, respectively.

CT-SCAN Service Timing

The time of performing each of the selected services had to be examined to determine the cost of services. For this purpose, performing CT services with and without injection was calculated to check the mean and some selected services such as CT of the brain, spine, limbs, etc. The calculated time was estimated to include routine services at the beginning of each shift and patient admission, training the patient to prepare for imaging, placing the patients on the bed, preparing them for imaging, imaging, viewing the images, reconstructing images, and preparing the final report. In addition to the total observed time of activity and the sub-time of activity and overall, by taking into account the allowed rest time for employees, the average time of all CT steps was determined separately. The results of the timing of the selected CT services in minutes are as follows: performing all CTs of the brain without injection was 8.3, chest without injection 10.5, upper or lower extremity without injection 14.67, neck or chest or back without injection 9.87, pelvis without injection 10.56, and without injection 10.7. In addition, the time of all stages of chest scan with injection was 20.34, Carotid (extracranial) CT angiography 18.76, thoracic aortic angiography 24.56, abdomen, and pelvis CT by injection 21.34 minutes (Table 2).

The Weighting of Selected Services of CT Unit

After obtaining the timing results, we weighted the selected services to calculate the cost of the chosen services by using the number of cases of performing the selected services and the time of performing the service. Among the CT services, CT of the brain without injection, CT of the abdomen and pelvis with injection, CT of the abdomen without injection, CT of the chest without injection, and CT of the limb without injection per year obtained more weights due to the number of cases per year.

Cost of Selected CT Scan Services Disregarding the Cost of Depreciation of the Building

Cost per service without calculation of building depreciation cost for CT of the brain without injection was $76.1, brain with injection 164 $, chest without injection $96.2, chest with injection $186.4, upper and lower limbs without injection $134.4, spine without injection $90.4, abdomen and pelvis without injection $96.8, abdomen and pelvis with injection $195.5, sinus $98, carotid angiography (extracranial) $171.9, and aortic angiography $225. The tariffs of selected CT scan services are shown in Table 3.

The total cost of the CT was $1687671.6, of which CT scan of the brain without injection $322297.2 (19.10%), abdomen and pelvis with injection $180642 (10.70%), upper and lower limbs without injection $134131.6 (7.95%), sinus $146451.1 (8.68%), abdomen and pelvis without injection $58284.9 (3.45%), and spine $53467.7 (3.17%) account for the largest share of total CT costs, respectively (Table 4).

Cost of Selected Services of CT Unit Considering the Cost of Building Depreciation

The costs for each service by calculating the depreciation cost of the building based on the Rials

Table 2: The final calculated time of the computed tomography services

Type of Services	Time (Minutes)
Brain without contrast	8.3
Brain with contrast	17.9
Chest without contrast	10.5
Chest with contrast	20.34
Upper& Lower Limb	14.67
Spine (cervical or thoracic or lumbar)	9.87
Carotid CT angiography (extra cranial)	18.76
Thoracic aortic CT angiography	24.56
Abdomen and pelvis without contrast	10.56
Abdomen and pelvis with contrast	21.34
Sinus	10.7

Table 3: Cost per service with and without calculating the cost of the computed tomography building depreciation and their tariffs

Type of service	Cost with considering building depreciation ($)	Cost without considering building depreciation ($)	Tariffs ($)
Brain without contrast	76.1	77.1	41
Brain with contrast	164	166.3	48
Chest without contrast	96.2	97.6	45.8
Chest with contrast	186.4	189	53
Upper& Lower Limb	134.4	136.3	110.8
Spine (cervical or thoracic or lumbar)	90.4	91.7	46.8
Carotid CT angiography (extracranial)	171.9	174.3	112.1
Thoracic aortic CT angiography	225	228.2	108
Abdomen and pelvis without contrast	96.8	98.1	55
Abdomen and pelvis with contrast	195.5	198.3	59.8
Sinus	98	99.4	41

Table 4: Cost-share of service from the final costs of the computed tomography services

Services	Cost ($)	Percent
Brain without contrast	322297.2	19.1
Brain with contrast	14803	0.88
Chest without contrast	75222.8	4.46
Chest with contrast	76355.2	4.52
Upper& Lower Limb	134131.6	7.95
Spine (cervical or thoracic or lumbar)	53467.7	3.17
Carotid CT angiography (extra cranial)	10459	0.62
Thoracic aortic CT angiography	27385.2	1.62
Abdomen and pelvis without contrast	58284.9	3.45
Abdomen and pelvis with contrast	180642	10.7
Sinus	146451.1	8.68

are as follows: CT of the brain without injection $77.1, brain with injection $166.3, chest without injection $97.6, chest with injection $189 PPP, upper and lower extremities $136.3, spine $91.7, abdomen and pelvis without injection $98.1, abdomen and pelvis with injection $198.3, sinus $99.4, CT of the carotid (extracranial) angiography $174.3, and aortic CT angiography $228.2 (Table 3).

Discussion

The present study results showed that the share of general and overhead costs and personnel costs of the CT unit of the radiology department was calculated $1242661.7. A similar study conducted at Amir Alam Hospital in Tehran in 2007 with a step-down method showed that the share of general, overhead, and personnel costs of the Radiology Department was $805595.3, of which 63.4% of the public and personnel costs of the Radiology Department was allocated to the CT unit.[16] In addition, the total costs of the CT unit estimated by considering the equipment depreciation were $166426.1. In contrast, in the same research in Amir Alam Hospital, the total cost was calculated $632739.5.[16] These results show that CT unit costs increase over time due to increased parts prices, repairs, overhead, and personnel costs. The average cost of each CT service with and without considering the building depreciation cost was calculated at 122.1 and $120.5, respectively, which is close to the other results due to the low depreciation cost of the CT building. The equipment cost in the above results was 314830 Rials per CT service. Another study in Imam Khomeini Hospital in Tehran in 2010 showed that the cost of performing each CT was $213.9, of which 51% was the determined share of personnel costs and 49% were non-personnel expenses.[6] Also, the share of some selected services, such as CT of the brain without injection$ 66.7, brain with injection $143.9, chest without injection $84.4, chest with injection $163.5, upper and lower limbs without injection $150.1, spine (neck, chest, back) $135.6, abdominal and pelvis without injection 149.2, abdominal and pelvis with injection 243.9, sinus $94.1, carotid (extracranial) CT angiography $324.6, thoracic aortic CT angiography $277.8, showed the effect of time. Consequently, the decreased services increased the total cost of some services like abdominal and pelvic CT with injection, CT of the limb, and CT angiography.

In addition, the study of Nisenbaum et al. showed that brain CT with contrast (70450 patients), chest CT with distinction (7120 patients), and abdominal CT with contrast (74,160 patients), which included 71.2% of the total CT scans, were 189.19, 273.53 and 343.20 $, respectively. According to the results, the technical costs were higher than expected in the study time period.

On average, the cost of each non-contrast, with contrast, and combined scanning head was estimated to be 189.19, 247.7, and 252.83 $, respectively. CT of the jaw and face without contrast and neck with contrast was calculated at 171.38 and $273.51, and CT of the chest with a difference and without distinction, 273.53 and 218.86 $, respectively.[5] In addition, in this study, the share of personnel costs related to performing each CT was calculated to be $63/9 PPP. Meanwhile, the study of Imam Khomeini Hospital in Tehran in 2010 showed that the highest cost of the workforce was related to performing each CT with $109. Also, the most increased non-personnel cost among radiology services was serving each CT with $105.[11] In a study conducted at Amir Alam Hospital, it was found that personnel costs had the largest share among the current costs (66.19%) as well as the total ward costs (62% of total ward costs). In another study in the Dominican Republic, Lewis et al. found that about 84% of a hospital total budget was spent on the workforce.[18](Ref 17???) The survey of Ghiasvand et al. showed that the largest share of costs incurred to provide radiology services in all four hospitals studied in 1389 and 1390 was related to direct operating costs to compensate for services delivered by the main sources and the difference between these costs was significant. Since, in the present study, the workforce cost was also classified as direct and operational costs, the workforce (personnel) had a considerable share in costs.[10] Another study conducted by Ahmadi et al. to determine the cost of health services showed that the largest share of costs was related to personnel costs. The unit type varied between 46.5% to 61.5% of total costs.[19]

Laurila and colleagues conducted a study using both conventional and activity-based costing methods. Cost data in this study were obtained from information recorded in radiology and the hospital financial and personnel system. The costs allocated to radiology and admission technicians were between 57999 and $150622, physicians between 52398 to $83462, equipment between 93799 and $136608, and the cost of materials and support services ranged from 40381 to $110592.[20]

A study by Ibrahim et al. showed that the cost of radiology services was $8, while the cost calculated based on the activity-based costing method was $122.2. The results showed that human resources were the main cost of radiology services among the four direct costs. Among the costs associated with human resources (employed personnel) and the services provided, radiology, CT, and sonography had the largest share, respectively. In addition, vascular system tests had the highest cost of consumables and medicines.[21]

The results obtained from Niasti et al.'s study in Shahid Beheshti Hospital of Hamadan showed that the highest cost was related to the workforce (65.2%) and the lowest was to energy consumption (0.4%). In addition, the total cost covered the costs of consumables (8.3%), public services (5.1%), and equipment and repairs (5.4%). The results of this study show a significant difference between the actual price of radiology services and tariffs. According to the results, for controlling the costs and creating a balance between revenues and expenses until the issuance of new tariffs, the reform of financial structures, personnel, repairs, and use of accurate accounting methods should be considered.[22] The results of these studies confirm those of the present study. The current study results show that a shorter time of services and delivery of more services in the MRI and CT unit would lower the cost of services. Therefore, the burden of patients referring to imaging centers should be the basis for management decisions to restrict time-consuming services to provide more patients and reduce queue wait times.

It is suggested that the accounting and financial management in hospitals should be reformed. Calculating the cost of services in different parts of the hospital to provide a correct analysis of the costs, revenue, profit, and loss and making the right decision in resource management are recommended in order to provide the best quality services at the lowest price.

One of the limitations of this study was the deficiency of the accounting system of the hospital under study, which did not allow displaying the detailed costs of each activity center.

Conclusion

Comparison of the cost of CT scan services in the present study showed that some services requiring injection before CT were time-consuming. Therefore, it reduced the number of CT services in this unit and increased the tariff and service costs. Consequently, it is suggested that in cases where the patient's burden is high, prioritization of patients by the management of the radiology department should be considered to receive CT services that need to be injected. This can help adequately manage the resources to respond appropriately to patients and reduce the burden of CT centers by providing services that take a short time to be performed and have more patients.

Authors' Contribution

HY, KH, and BN conceived the study and designed its method. HY performed the computations. KH, AG, and BF wrote the manuscript. All authors contributed to the development and approved the final manuscript.

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This study was approved by the ethics committee of Urmia University of Medical Sciences with the code of IR.UMSU.REC.1398.319. The authors acknowledge the staff of Imam Reza hospital for providing the hospital data.

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ORIGINAL ARTICLE

Maternal Risk Factors Associated with Low Birth Weight among in Term Newborns in Abadan University of Medical Sciences: A Nested Case-Control Study

Neda Amoori[1], PhD;
Haydeh Ghajari[2], MSc;
Belghis Afkaneh[3], MSc

[1]Department of Epidemiology, Abadan University of Medical Sciences, Abadan, Iran
[2]Department of Health Education, Abadan University of Medical Sciences, Abadan, Iran
[3]Department of Social Sciences-demography, Abadan University of Medical Sciences, Abadan, Iran

Correspondence:
Haydeh Ghajari, MSc;
Department of Health Education.
Abadan University Of Medical Sciences, Abadan, Iran
Tel: +98 9370072887
Email: h.ghajari2012@yahoo.com
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Abstract

Background: Low birth weight (LBW) can cause complications and disorders in the future life of newborns. This study aimed to investigate maternal risk factors affecting low birth weight among term newborns in the affiliated cities of Abadan University of Medical Sciences based on a nested case-control study.

Methods: In this study, based on the nested case-control design, namely with the risk set sampling approach, the case and control groups were selected. All in-term newborns born since the beginning of 2018, with less than 2500g birth weight, were considered as the case group. Two were randomly selected as controls from newborns born in the same time frame and geographical location and with over 2500g birth weight. The selection ratio of the cases to control was 1:2. The questionnaires were completed from the beginning of 2019 to the end of 2020. To describe the data, descriptive statistical indicators including mean, standard deviation, frequency, and logistic regression were used in this method.

Results: The results of this study indicate that the factors affecting LBW are maternal age, number of pregnancies, number of abortions, history of stillbirth, history of bleeding, mother's BMI, number of births, twins, and gestational intervals.

Conclusion: It is suggested that health policymakers should pay special attention to the necessary interventions for mothers with special pregnancy care conditions. In addition, it is necessary to pay more attention to the continuation and improvement of the quality of educational programs for health and medical personnel to increase the mothers' awarenessregarding the maintenance of a healthy lifestyle during pregnancy.

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Keywords: Maternal risk factors, Low birth weight, Abadan, Nested case-control

Introduction

A very sensitive index of children's health is birth weight. Low birth weight (LBW) can cause complications and disorders in the future life of infants.[1] The newborns' mortality rate is one of the most important health indicators of every society that is affected by various factors. LBW is one of the leading causes of mortality in suckling babies and infants.[2] For the first time in 1919, Ylppo named 2,500-gram newborns LBW, and this definition has been approved by the World Health Organization (WHO) for many years as a global

standard for low birth weight.[3] However, two critical factors, namely gestational age at delivery and the rate of fetal growth, are used to determine the birth weight[4] Subsequently, factors determining low weight may be different between preterm and term newborns because, in the case of the preterm newborn, usually prematurity explains low weight, while in the term newborn, the result of intrinsic and extrinsic factors influences the development potential.[4, 5]

LBW newborns are 24 times more likely to die than normal-weight newborns, and their mortality in infancy is even 40 times more than that in normal-weight newborns. These children are also at greater risk of death before the age of 15.[6] Although one of the goals set at the World Summit for Children in 1990 was to reduce the prevalence of LBW to less than 10 percent by 2000, the problem remains unresolved in the 21st century, according to WHO reports.[7] In terms of continental division, the prevalence of low weight in Africa is 18.3%, Asia 14.3%, Europe 6.4%, Latin America and the Caribbean 10%, North America 7.7%, and Oceania 10.5%; also, based on studies in Iran, it has been reported between 8 and 10%.[8] A study by Mehdi Shokri et al. reported the prevalence of low birth weight as 7.9% in Iran and 4.9% in Ahvaz city.[9]

In Iran, 48% of mortalities in children under age 5 occur in the first month of life, and more than half of these deaths were due to low birth weight.[10] Factors affecting fetal growth and intrauterine weight may also affect the baby's health outcomes in later life. LBW leads to an increase in childhood mortality, disability, and disease.[11] Increased risk of ischemic heart disease, hypertension, diabetes in later life, hearing impairment, neurological and ocular complications, mental retardation, inadequate brain development, cerebral hemorrhage, decreased life expectancy, increased infectious and respiratory diseases, hypothermia, anemia, chromosomal abnormalities, disproportion of body organs, and nutritional and care problems are other complications of LBW.[12] Metabolic disorders in LBW newborns are 2 to 3 times more than normal-weight newborns.[13] Factors that affect LBW in newborns include maternal age at gestation, gestational intervals, maternal blood pressure, maternal blood type, body mass index, maternal RH, parental kinship, violence against women (physical and verbal violence), maternal depression, and its effect on maternal inattention to weight gain and care during pregnancy, marital satisfaction, infant gender, birth order, history of multiple births, poor nutritional status, inattention to proper diet and supplementation during pregnancy, birth season, number of prenatal cares, maternal anemia, which in turn causes preterm delivery and adverse effects on fetal intrauterine growth, and bleeding during pregnancy, all of which greatly increase the risk of LBW.[14-20] A nested case-control study is a kind of reserach based on the existence of a cohort. That is, it is a replacement for a prospective cohort. In this method, information about the exposure is collected from the beginning of the study and made available to researchers. Whenever the cases are identified, the controls are simultaneously selected from the same study population which has no consequences. If the controls are selected as a random sample based on the time each item was identified, this research method is called nested case-control design, incidence density sampling, or risk set sampling.[21] Although Iran has had significant success in reducing newborn mortality in the last two decades, LBW is still recognized as a major risk factor for infant mortality. In our country, LBW and investigating its causes are of great importance in the health system of the country. The present study was performed to determine the risk factors affecting the LBW in term newborns.

Methods

Thisis a nested case-control study. The proposal was approved by Abadan University of Medical Sciences with the ethics code of IR.ABADANUMS.REC.1397.025. Our study population consisted of pregnant mothers living in the affiliated cities of Abadan University of Medical Sciences who were followed up during pregnancy. As to the method of sample selection, firstly the separate statistics of low birth weight newborns born in the last few years in comprehensive centers of urban and rural health services of three cities affiliated to Abadan University of Medical Sciences were received from the newborn health expert in the vice-chancellery of health. Comprehensive urban and rural health service centers in these three cities, which had the highest number of LBW newborns in the last few years, were selected. In this study, based on the nested design, namely with the risk set sampling approach, the case and control groups were selected. All term newborns born since the beginning of 2018, with less than 2500g birth weight, were enrolled as the case group. Two were randomly selected as controls from among the newborns who were born in the same time frame and geographical location and with over 2500g birth weight. The selection ratio of the cases to the controls was 1:2. The questionnaires were completed from the beginning of 2019 to the end of 2020.

In this study, the inclusion criteria for the case group were pregnant mothers who gave birth to an LBW newborn during the project. Inclusion criteria in the control group were pregnant mothers who gave birth to a normal-weight newborn at the same time the LBW newborn in the case group was born. Exclusion criteria included LBW premature newborns (less than 37 weeks) or abortion or stillbirth in pregnant women or refusal to participate in the project. In the current study, the questionnaire of Khazaei et al.'s study in Kurdistan was used.[22] Considering all the variables

and related factors for both case and control groups, an interviewer in each health center completed the questionnaire according to the pregnancy records available in the centers. The required questions were asked by the interviewer to the mothers and recorded in the questionnaire according to the mothers' statements. The questionnaire consists of 5 sections with 12 questions about demographic information in the first section, 10 questions about the history of the mother in the second section, 12 questions about the mother's history or illness during pregnancy in the third section, 4 questions about the results of mother's tests and routine care in the fourth section, and 6 questions about the condition of the newborn in the fifth section.

In this method, from the beginning of the research,information was collected, recorded, and provided to the researcher. By the time the case was identified in the study, the control which was a newborn weighing more than 2500 grams was selected from the same population under study.

The collection of data and information required for the case and control participants in this study was performed by reviewing their household records available in the health centers. Data were collected from the beginning of 2019 to the end of 2021.

Considering 95% confidence, 80% test power, control ratio to case 2, and a correlation coefficient of 20%, the exposure between case and paired controls[23] as well as the odds ratio of at least 2,[24] and the exposure rate 20 percent in the control group, finally the minimum sample size was estimated 155 (low birth weight newborns) in the case group and 310 (normal weight newborns) in the control group. Therefore, the minimum sample size in this study was equal to 465 newborns. In this study, descriptive statistical indicators including mean, standard deviation, and frequency as well as tables and graphs were used to describe the data. The analysis of the nested control case was performed using SPSS software.

Results

The results of this study showed that most of the mothers in the case group (80%) and the control group (75.8%) were in the age group of 20-35 years, and the highest level of education in both case (32.5%) and control groups (30.8%) was the middle school. On the other hand, most mothers in the case (92.6%) and control groups (92.3%) were housewives. Also, 43.9% of mothers in the case group and 40.1% in the control groups were related to their spouse before marriage, and only 2.3% of mothers in the case group and 1.6% of controls had a history of divorce (Table 1). There was no statistically significant difference between the case and control groups in any of the studied variables (P>0.05).

According to the results of the univariate analysis, factors affecting LBW were maternal age, number of pregnancies, number of abortions, stillbirth, history of bleeding, maternal BMI, twins, and gestational intervals. The results of multivariate analysis showed that the risk of LBW in normal-weight mothers (18.5≤BMI<24.9) was almost 4 times lower than in low-weight mothers (BMI<18.5), [OR=0.4, 95% CI: (0.1,1.6)]; however, the risk was lower in overweight mothers (BMI≤25) than in low-weight ones. Also, the risk in mothers with a history of stillbirth [OR=2.3, 95% CI: (0.3,5.8)], gestational intervals [OR=2.7, 95% CI: (1.8,3.6)], and twins [OR=2.3, 95% CI: (1.4,4.6)] was about 2 times more than other pregnant mothers (P<0.05).

Other variables examined in this study, such as the mother's level of education and occupation, relatives, parental divorce history, number of deliveries, IVF, history of smoking, history of exposure to cigarette smoke, self-medication or arbitrary use of drugs, drug use under medical supervision, psychological tension, RH, number of visits to the doctor, infant gender, birth order, birth season, history of maternal diseases during pregnancy was not significantly effective in birth weight. The results are shown in Table 2.

Table 1: Maternal demographic variables in the case and control groups

Variable		Case	Control	Chi-2	P
Maternal age	19<	8 (5.1)	14 (45)	4.1	0.51
	2035	124 (80)	235 (75.8)		
	35≤	26 (16)	61 (19.6)		
Maternal education	Illiterate	18 (11.6)	16 (5.1)	5.6	0.23
	Elementary	36 (23.2)	86 (27.6)		
	Middle school	50 (32.5)	96 (30.8)		
	High school	41 (26.5)	85 (27.2)		
	Academic	9 (5.8)	25 (8)		
Maternal job	Housewife	143 (92.3)	289 (92.6)	0.32	0.85
	Employee	9 (5.8)	19 (4.8)		
Relative	No	84 (54.2)	178 (57.1)	0.5	0.47
	Yes	68 (43.9)	125 (40.1)		
Parental divorce history	No	149 (96.1)	301 (96.5)	0.51	0.47
	Yes	4 (2.6)	5 (1.6)		

Table 2: Univariate and multivariate analysis of risk factors affecting LBW in the case and control group

Variable		Groups		Unadjusted OR (95% CI)	P	Adjusted OR (95% CI)	P
		Case (n=155)	Control (n=310)				
Maternal age	19<	8 (5.1)	14 (45)	1	--	1	--
	2035	124 (80)	235 (75.8)	0.9 (0.9-1.0)	0.001	1.0 (0.9-1.0)	0.6
	35≤	26 (16)	61 (19.6)	0.4 (0.1-1.5)	0.2	1.4 (0.5-2.3)	0.1
Maternal education	Illiterate	18 (11.6)	16 (5.1)	1	--	1	--
	Elementary	36 (23.2)	86 (27.6)	0.8 (0.1-1.8)	0.4	1.3 (1.8-3.5)	0.1
	Middle school	50 (32.5)	96 (30.8)	1.6 (0.9-3.2)	0.6	1.1 (0.6-2.9)	0.5
	High school and diploma	41 (26.5)	85 (27.2)	1.8 (0.6-3.8)	0.1	1.7 (0.8-3.6)	0.8
	Academic	9 (5.8)	25 (8)	2.3 (1.5-4.3)	0.2	1.2 (0.3-2.9)	0.9
Maternal job	Housewife	143 (92.3)	289 (92.6)	1	--	1	--
	Employee	9 (5.8)	19 (4.8)	0.67 (0.69-6.53)	0.7	1.14 (0.87-1.51)	0.3
Paternal job	Unemployed	14 (9)	10 (3.2)	1	--	1	--
	Employee	8 (5.2)	19 (6.1)	0.55 (0.50-6.18)	0.6	1.3 (0.6-3.5)	0.8
	Freelance	122 (78.8)	266 (85.3)	0.9 (0.9-2.8)	0.4	1.8 (0.8-3.6)	0.4
Relative	No	84 (54.2)	178 (57.1)	1	--	1	--
	Yes	68 (43.9)	125 (40.1)	1.15 (0.77-1.70)	0.47	3.15 (1.30-7.65)	0.1
Number of pregnancies	The first	53 (34.2)	80 (25.6)	1	--	1	--
	2≤	98 (63.2)	220 (70.9)	1.1 (0.97-1.26)	0.03	1.6 (0.84-2.3)	0.01
Number of deliveries	The first	105 (67.7)	204 (65.8)	1	--	1	--
	2≤	50 (32.2)	106 (34.1)	1.2 (1.04-1.45)	0.01	1.8 (1.3-2.9)	0.6
Number of abortions	0	119 (76.7)	236 (75.6)	1	--	1	--
	1≤	29 (18.8)	52 (17.2)	1.0 (0.88-1.20)	0.1	1.0 (0.42-2.66)	0.8
Stillbirth	No	73 (4.5)	294 (94.2)	1	--	1	--
	Yes	143 (92.3)	9 (2.9)	1.3 (0.61-2.83)	0.01	2.3 (0.34-5.8)	0.03
Gestational interval	2<	70 (45.2)	126 (40.6)	1	--	1	--
	≤2	55 (35.5)	136 (43.6)	1.3 (1.01-1.81)	0.04	2.7 (1.83-3.64)	0.01
IVF	No	153 (98.7)	303 (97.1)	1	--	1	--
	Yes	1 (0.6)	3 (1)	0.8 (0.4-1.2)	0.1	0.9 (0.6-1.4)	0.9
BMI Maternal	18.5<	32 (20.6)	42 (13.5)	1	--	1	---
	18.524.9	81 (52.2)	189 (60.2)	0.9 (0.4-1.3)	--	0.4 (0.1-1.6)	0.04
	25≤	41 (26.5)	73 (23.4)	0.5 (0.1-0.8)	0.01	0.2 (0.06-0.8)	0.01
Bleeding	No	139 (89.7)	289 (92.6)	1	--	1	--
	Yes	13 (8.4)	14 (4.5)	1.3 (0.7-2.3)	0.03	4.3 (0.42-6.4)	0.02
History of smoking	No	151 (97.4)	300 (96.2)	1	--	1	--
	Yes	1 (0.3)	5 (1.5)	1.5 (0.4-5.2)	0.5	1.7 (0.2-2.4)	0.8
History of contact with cigarette smoke	No	39 (25.2)	90 (28.8)	1	--	1	--
	Yes	4 (2.6)	5 (1.5)	1.0 (0.9-1.1)	0.9	1.5 (0.9-2.7)	0.5
Disease history	Diabetes	3 (1.9)	10 (3.2)	2.1 (0.4-9.2)	0.3	1.8 (0.2-3.6)	0.6
	Hypertension	11 (7.1)	8 (2.6)	0.4 (0.1-1.5)	0.1	0.2 (0.01-2.64)	0.8
	Anemia	27 (17.4)	59 (18.9)	1.3 (0.5-3.3)	0.5	2.2 (0.8-6.6)	0.08
	Urinary and genital infections	4 (2.6)	7 (2.2)	1.0 (0.2-4.6)	0.9	0.7 (0.2-2.4)	0.4
	Hypothyroidism	7 (4.5)	5 (1.6)	0.4 (0.1-1.7)	0.2	0.7 (0.4-1.1)	0.6
	Hyperthyroidism	2 (0.4)	1 (0.3)	2.1 (0.81-5.66)	0.6	2.8 (1.9-7.8)	0.7
	Thalassemia	6 (3.9)	9 (2.9)	0.9 (0.2-3.3)	0.8	0.7 (0.08-0.7)	0.1
	Oral and dental	3 (1.9)	4 (1.3)	0.8 (0.1-4.4)	0.7	0.9 (0.6-1.9)	0.9
Self-medication arbitrary use of drugs	No	145 (93.5)	296 (94.9)	1	0.8	1	0. 4
	Yes	3 (1.9)	1 (0.3)	1.8 (1.1-3.2)		2.6 (1.4-3.8)	
Drug use under medical supervision	No	121 (78.1)	245 (78.5)	1	0.6	1	0.1
	Yes	29 (18.7)	59 (18.9)	0.5 (0.2-1.1)		1.8 (0.6-2.3)	
Psychological tension	No	130 (83.9)	283 (90.7)	1	--	1	--
	Yes	19 (12.3)	22 (7.1)	0.6 (0.2-1.1)	0.7	0.9 (0.2-4.3)	0.9
RH	Rh+	110 (71)	253 (81.8)	1	--	1	0.6
	Rh-	17 (11)	17 (5.4)	2.0 (1.2-3.5)	0.4	1.3 (0.4-4.2)	0.6
Number of visits to the doctor	≤5	103 (66)	203 (65)	1	--	1	----
	6-9	20 (13)	54 (17)	1.0 (0.9-1.0)	0.7	0.8 (0.1-2.5)	0.6
	10≤	4 (2.6)	5 (1.6)	0.9 (0.8-1.1)	0.9	0.5 (0.04-1.8)	0.1
Infant gender	Girl	78 (50.3)	149 (47.8)	1	--	1	--
	Boy	73 (47.1)	160 (51.3)	1.1 (0.7-1.6)	0.4	1.5 (1.2-2.8)	0.8

Multiple births	Single twin	120 (77.4)	297 (95.2)	1	--	1	--
	Twin	33 (21.3)	9 (2.9)	1.9 (1.1-2.8)	0.001	2.3 (1.4-4.6)	0.02
	More than two	1 (0.6)	306 (98.1)	0.1 (0.5-0.2)	0.9	0.5 (0.1-1.4)	0.3
Birth order	2<	90 (58)	175 (56.4)	1	--	1	--
	2≤	57 (36.7)	126 (40.6)	1.0 (0.9-1.2)	0.2	0.8 (0.5-1.3)	0.6
Birth season	Spring	46 (29.7)	95 (30.4)	1	--	1	---
	Summer	67 (43.2)	117 (37.5)	2.3 (1.0-5.2)	0. 3	0.8 (0.02-2.5)	0.1
	Autumn	24 (15.5)	81 (36)	1.9 (0.9-4.3)	0.05	1.1 (0.5-3.6)	0.8
	Winter	16 (10.3)	14 (4.5)	3.8 (1.6-9.0)	0. 1	2.4 (1.2-4.6)	0.3

Discussion

LBW affects the physical and mental development of children and causes serious complications and mortality in newborns. Studies have shown that the prevalence of LBW in Iran is 8%.[25] This study aimed to determine the factors affecting the low birth weight among term newborns in the affiliated cities of Abadan University of Medical Sciences (nested case study). According to the results, factors affecting LBW were maternal age, number of pregnancies, number of abortions, stillbirth, history of bleeding, maternal BMI, twins, and gestational intervals. Other variables examined in this study, such as the mother's level of education and occupation, relatives, parental divorce history, number of deliveries, IVF, history of smoking, history of exposure to cigarette smoke, self-medication or arbitrary use of drugs, drug use under medical supervision, psychological tension, RH, number of visits to the doctor, infant gender, birth order, birth season, history of maternal diseases during pregnancy were not significantly effective in birth weight.

In the present study, the highest rate of LBW newborns was in mothers aged 20 to 35 years old. The rate of LBW newborns in mothers aged 35 and above was more than that of those under 19 years old, which is consistent with a study[26] in which the highest prevalence of LBW newborns was in mothers aged 18 to 35.

The results of the present study show that there is no statistically significant difference between the control and case groups in terms of mothers' education level, and more than 80% of the mothers in the control and case groups had school education. Only 8% in the control group and 5.8% in the case group had academic education. This result shows that mothers' education does not show a statistically significant relationship with the birth of a low birth weight newborn, which is consistent with the study of Mohammadi et al.[26] Although the results of Shokri et al.'s study[9] showed that the mother's job was one of the factors affecting the birth of a low birth weight newborn, the results of the present study showed that most of the mothers were housewives (92%), and no significant relationship was observed between the mothers' jobs and low birth weight newborns. This result is consistent with the study of Mohammadi et al.,[27] and that conducted in Qatar.[28]

Gestational age is another factor influencing the birth of LBW newborns. A study by Mosayebi et al. showed that more than 50% of LBW newborns were preterm.[29] Also, Momeni et al. found that in 75% of LBW cases, low gestational age and preterm delivery were the only effective factors.[30] Due to the clear impact of preterm delivery on birth weight, in the current study we only examined newborns who were over 37 weeks and term.

This study shows that twin births are the factors influencing LBW newborns, and the mothers who have a history of twin births are twice as likely as other mothers to have an LBW newborn. The results of the studies by Mirzarehimi et al.[31] and Asgharian et al.[32] showed that twins and multiple gestations are known as effective factors for low birth weight. This is consistent with the results of the current study.

The present study showed that mothers whose gestational intervals were 2 years or less were twice as likely to have LBW newborns. The results of the study by Shokri et al. are consistent with those of the current study,[9] showing that the birth order and gestational intervals over 2 years affect the birth weight of the newborn.

According to the results of the present study, the number of LBW newborns born to normal-weight mothers was 4 times lower than those born to mothers with a body mass index of less than 18.5. The risk of an LBW newborn in mothers with an overweight body mass index was lower than that in low-weight mothers. This finding is consistent with the results of a study by Khazaei et al.,[22] Nahar et al., Safari et al.,[33] Yuda et al.[34] and a study in India.[35] Maternal anthropometric characteristics such as weight and body mass index, which indicate sufficient energy intake, influence the placenta size and directly affect the newborn weight.[22]

The results of the present study showed that mothers with a history of bleeding during pregnancy were 4 times more likely than other mothers to have LBW newborns. The results of some studies,[8, 30, 36-38] also confirm the association between bleeding history and newborns' low weight. Bleeding or spotting in the second and third trimesters of pregnancy can cause conditions such as placental abruption, miscarriage, or preterm birth, resulting in an LBW newborn.[39]

Given that in this study only a few mothers stated that they had a history of smoking (6 people) or were exposed to cigarette smoke (9 people), the results showed low birth weight in newborns was not associated with drug use or exposure to cigarette smoke. This result is in the same line with that of the study conducted by Mohammadi[27] and Mirza Rahim et al.[31]

Also, the examination of the results in this study showed that there was no significant relationship between the mothers suffering from diseases such as diabetes, blood pressure, hypothyroidism or hyperthyroidism, anemia, thalassemia, oral and dental diseases, urinary infection during pregnancy and low birth weight newborn, which is consistent with the studies of Badshah et al.,[40] Feresu et al.,[41] and Sharma et al.[37] However, in a study by Moradi et al.,[15] the results showed that the rate of preterm newborns born to mothers with the disease was three times higher. Therefore, the investigation of diseases that are related to the birth weight of the newborn requires further studies to be conducted; considering the spread of the COVID-19 pandemic, the impact of this disease on the newborn weight can be investigated in future studies. The results of the current study showed that among the studied samples, only 4 mothers had used drugs arbitrarily and no significant relationship was observed between arbitrary use of drugs by the mother or under the supervision of a doctor during pregnancy and the low birth weight newborn; this is consistent with the study of Mohammadi et al.[27] However, given that many drugs cross the placenta and affect the fetus, this result needs further investigation.

The number of deliveries is one of the known factors in LBW among newborns. In this study, the number of pregnancies was significantly associated with low birth weight newborns. In a study by Yadav,[34] fourth or subsequent gestations were associated with low birth weight newborns. The results of a study on maternal determinants of low birth weight newborns in central India[42] indicated that in multiparous women whose gestational intervals were less than two years, a significant relationship was observed with low birth weight.

According to the results of the current study, mothers who had a history of stillbirth were twice as likely as other pregnant mothers to have a history of LBW newborns. The results of the study by Takai IU et al.[43] revealed that the history of stillbirth in the mother was one of the factors affecting the birth of LBW, which is consistent with the finding of the current study.

Another factor affecting LBW among newborns is the history of abortion in pregnant women. According to the results of Brown's study,[44] the history of previous abortion in a mother is an important risk factor for low birth weight. As the number of previous abortions increases, the risk of LBW is increased, too.

Some studies conducted in Iran regarding pregnancy with IVF have shown that IVF is effective on LBW newborns,[45] but considering that only 4 people in our study had IVF pregnancies, no significant relationship was observed between IVF and LBW newborns.

Conclusion

Based on the results of this study, the factors affecting the LBW newborns were variables such as the age of the pregnant mother, failure to observe the appropriate interval between births, number of pregnancies, and special care conditions in pregnant mothers (such as bleeding, history of abortion, history of stillbirth, and twins). It is suggested that health policymakers should pay special attention to the necessary interventions for mothers with special pregnancy care conditions. In addition, it is necessary to pay more attention to the continuation and improvement of the quality of educational programs for the health and medical personnel to increase the awareness of mothers regarding the maintenance of a healthy lifestyle during pregnancy.

Limitation

The long-term process of the project implementation and the completion of the questionnaire for LBW newborns and numerous sample sizes were the limitations of this study.

Acknowledgment

We appreciate the healthcare staff of Abadan University of Medical Sciences who helped us do this project.

Ethical Consideration

The proposal was approved by Abadan University of Medical Sciences with the ethics code of IR.ABADANUMS.REC.1397.025. Due to the coordination of the Deputy of Education and Research with the Deputy of Health of Abadan to coordinate the health centers of the three cities of Abadan, Khorramshahr, and Shadegan, the necessary explanations about the objectives and process of the study were provided in correspondence by Abadan University of Medical Sciences. Written consent was obtained for all the study participants to review their household records.

Conflict of Interest: None declared.

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ORIGINAL ARTICLE

High-risk Driving and Its Associated Observable Driving Behaviors, Police Records, and Car Condition: A Case-control Study

Masumeh Daliri[1], MSc;
Hesamuddin Taheri[2], PhD;
Mohammad Fararouei[3], PhD

Abstract

Background: The incidence of traffic accidents in Iran is significantly higher than the global average (more than 17000 deaths a year, mostly young adults). The aim of this study was to determine the risk factors of high-risk drivers based on their observable driving behaviors, police records, and car condition in Fars province (Iran).

Methods: In this case-control study, an interviewer interviewed a random sample (about 1 in 5 of the drivers) of all drivers who were referred to Shiraz traffic accident court from March 21, 2021, to June 21, 2021, due to being involved in a traffic accident. Based on the police report, we interviewed at-fault drivers who caused injurious or fatal traffic accidents as the case group (200 at-fault drivers) and those not-at-fault drivers as the control group (200 not-at-fault drivers). No matching was done. Data were collected using a researcher-made questionnaire filled out through face-to-face interviews with the drivers. Using univariate and multivariate logistic regression, the statistical analyses were conducted in R 4.0.2 software.

Results: In this study, a total of 400 drivers were interviewed, of whom 367 (91.8%) were male. The mean ages of the case and control groups were 32.35 years (SD=9.84) and 31.75 (SD=10.33) years, respectively (P>0.05). In addition, 102 (51.0%) and 95 (47.5%) drivers were married in the case and control groups, respectively. Based on the results of a multiple logistic regression model, statistically significant associations were observed between the risk of being the at-fault driver in an injurious or fatal traffic accident and receiving a traffic ticket due to speeding-overtaking ($OR_{speeding\text{-}overtaking/no\ ticket}$=3.38, 95%CI: 1.75, 6.49, P<0.001), self-reported high-speed driving ($OR_{yes/no}$=2.41, 95%CI: 1.25, 4.63, P=0.008), and having a history of car accident within the recent two years ($OR_{yes/no}$=1.87, 95%CI: 1.11, 3.14, P=0.017).

Conclusion: Our study suggested that among several potential factors, recently receiving traffic tickets due to speeding or overtaking, self-reported speed driving, and recent car accidents may effectively be used to screen out high-risk drivers who will probably cause injurious or fatal car accidents in the future. Intervention measures for the defined high-risk drivers including closer supervision and training programs may reduce the risk of fatal accidents in Iran.

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[1]Student Research Committee, Shiraz University of Medical Sciences, Shiraz, Iran
[2]Department of Social Sciences, Faculty of Literature and Humanities, Islamic Azad University, Jahrom Branch, Shiraz, Iran
[3]Department of Epidemiology, School of Health, Shiraz University of Medical Sciences, Shiraz, Iran

Correspondence:
Mohammad Fararouei, PhD;
Department of Epidemiology, School of Health, Shiraz University of Medical Sciences, Shiraz, Iran
Tel: +98 9173107059
Email: fararooei@gmail.com
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Introduction

Road traffic accidents (RTAs) are recognized as the most common types of fatal/injurious accidents and considered as major challenges for public health and social development.[1, 2] According to the World Health Organization (WHO), traffic accident is currently the eighth leading cause of death in the world, 73% of which occur among young men under 25 years of age.[3] If no effective interventions are made to reduce the above figures, by 2030, road traffic accident will have been the fifth leading cause of death in the world.[4]

Studies show that human factors account for 70-90% of traffic accidents.[5, 6] However, safe driving is not enough in preventing road traffic accidents as car accidents are also caused by several multidimensional mechanisms including the vehicle condition, infrastructure of the road, and law enforcement.[7, 8] Studies have reported several factors such as gender, employment, and age of the driver, fatigue, driving with no valid license, vehicle safety, visibility, and time of the day that seem to alter the risk of accident and its severity.[9-11]

Although the above factors are undoubtedly important in traffic accidents, they are not globally and practically usable in effectively recognizing high-risk drivers in different communities. For example, researchers from different countries diversely suggest that accidents leading to serious injuries are affected by the driver's age.[10, 12]

In terms of traffic accidents, Iran is ranked fifth in the world, with more than 17000 deaths due to traffic accidents nationally. In Iran, Fars is a large province where the number of traffic accidents is so high that, according to the statistics from the Iranian Forensic Medicine Organization, this province ranks first regarding the number of deaths due to traffic accidents.[13, 14] Despite the importance of injurious and fatal traffic accidents, our knowledge about the contributors of such accidents is sparse as no study was found to investigate this issue in Iran. Therefore, it is important to identify the factors affecting the occurrence of traffic accidents, especially those resulting in injury or death in Iran. In this regard, several studies have been conducted to define high-risk driving behaviors that are involved in injurious traffic accidents. By focusing on the factors detectable by traffic surveillance systems, the aim of this study was to identify the human and observable car factors which contribute to serious (fatal or injurious) traffic accidents. We aimed to investigate if the contributing factors introduced by studies from other countries are also important in Iran and identify Iranian high-risk drivers based on a few remotely measurable/observable behaviors using police records and traffic cameras. By being detected and screened out, high-risk drivers can undergo necessary preventive interventions to reduce the risk they cause and prevent life and economic losses due to these types of accidents.

Methods

Setting

This study was conducted in the capital of Fars province (Shiraz city) with a population of about 1,869,000 individuals. Fars province is in the southern part of Iran with a population of 4851274 individuals with a road coverage of 7367 km. Also, in Iran all car crashes are registered by traffic police and those with serious consequences (injurious or fatal car accidents) are investigated in a court specialized in traffic accidents. All drivers who were selected in the current study had finished the judicial investigation procedures and were about to receive the final court verdict. In this case-control study, the study population consisted of car drivers who were involved in a traffic accident.

Selection of Case and Control Participants

Drivers who were at-fault in an injurious or fatal traffic accident and whose case was being investigated by the court from March 21, 2021 to June 21, 2021 were selected as the case group.

Not-at-fault drivers who were involved in an accident and whose case was being investigated by the court during the above period were selected as the control group. All accidents were recorded and investigated by traffic police officers.

Inclusion Criteria

All drivers were involved in a traffic accident that was being investigated by the traffic accidents court during the study period. Drivers were healthy enough to be interviewed. Vehicle occupants and bicycle and motorcycle riders were not included. Before the interview, a trained interviewer provided the necessary explanations to the selected drivers, and verbal consent was obtained from the participants as a significant number of the drivers were illiterate. The study protocol was reviewed and approved by the research and ethics committee of Shiraz University of Medical Sciences (ethical approval no: IR.SUMS.REC.1400.787).

Sampling and Sample Size Calculation

The participants were selected randomly (about 1 in 5 of the drivers) from drivers who had just finished the judicial investigation procedures and were about to receive the final court verdict. As to the objectives of the research, the drivers answered the questions if they expressed their oral consent (a significant number of the participants were illiterate). The required sample size of the current study was estimated to be 400

for detecting any type of association between being involved in a fatal/injurious car accident as an at-fault driver and recent history of a car accident (n=200 as cases and n=200 as controls).

Data Collection

Data were collected using a researcher-designed questionnaire through a face-to-face interview. The content validity of the questionnaire was approved by a group of experts (two traffic police officers, one epidemiologist, and one health nurse); the reliability of the questionnaire was evaluated using the test-retest approach with a two-week interval (Cronbach's alpha=0.89). Before the interview, a trained interviewer provided the selected drivers with necessary explanations regarding the objectives of the research. The drivers answered the questions if they expressed their oral consent (a significant number of the participants were illiterate). The questionnaire consisted of 4 sections namely demographic status, behavioral factors, driving history, condition of the vehicle, and environmental factors at the time of the accident.

The studied variables included three categories: 1) demographic variables: age (years), gender, marital status (married, other); job (employed/student, self-employed, driver), education (<diploma, diploma, >diploma), perceived income (low, moderate good), and score (a score that drivers gave themselves from zero to ten in terms of compliance with driving rules).

2) driving behaviors: over-speeding (never, sometimes, always), using a mobile phone while driving (never, occasionally, always/ringing), having spiral movement (never, sometimes, always), parking parallelly (never, Sometimes/Always), using the turn signals, contravening red traffic light, contravening zebra crosswalk, wearing a seat belt while driving, cleaning the car (often dirty, often clean, always clean), and replacing defective headlights (replacement period of defective car headlights). All information was self-reported.

3) driving history: driving experience (year), hours of daily driving, date of issuing driving license (<5 years, >=5 years), history of collisions that required refinement, 0-1, >=2), the part of your car that was damaged (front, back, right and left), fines issued since 3 years ago (1-3, >=3), the reason for the last fine issued (no fine, speeding, overtaking, contravening red traffic lights, unauthorized stops, lack of wearing a seat belt, smoked glass, mobile phone use, not having a driving license or insurance, and alcohol consumption), time since the last accident (no accident; <2 years ago; 2-5 years ago; >5 years), and cause of the last accident.

Statistical Analysis

The statistical analyses were carried out using R 4.0.2 software. For descriptive analysis of the quantitative variables, median and interquartile ranges were calculated and for categorical variables, absolute and relative frequencies were used. We used univariate logistic regression to determine the unadjusted associations between the study variables and the odds of being the at-fault drivers in injurious or fatal car accidents. Finally, multivariate logistic regression with a stepwise variable selection strategy was used to measure the adjusted relationships of the study variables with the outcome. The significance level was set at P<0.05.

Also, we used the receiver performance characteristic curve (ROC) and area under the curve (AUC) to measure the ability of the final model (in terms of sensitivity and specificity) in detecting drivers who were prone to cause fatal accidents.[15] AUC <0.5 was considered as no discrimination, 0.7 to 0.8 as acceptable, 0.8 to 0.9 as excellent, and more than 0.9 as prominent.[16]

Results

In this study, a total of 400 drivers were interviewed (200 drivers in each of the case and control groups), of whom 367 (91.8%) were male. The mean ages of the case and control groups were 32.35 years (SD=9.84) and 31.75 (SD=10.33) years, respectively. In addition, 102 (51.0%) and 95 (47.5%) drivers were married in the case and control groups, respectively. Most of the drivers in the case (43.5%) and control groups (46.0%) had finished their mandatory education (diploma) and more than half of the drivers in both groups were self-employed. The perceived income level of about half of the drivers in the two groups was moderate. Also, 25% of people in the case group and 13% in the control group reported a history of alcohol consumption while driving (Table 1).

Table 1 also shows significant unadjusted associations regarding the history of alcohol use (P=0.003), always high-speed driving (P<0.001), always spiral movement (P=0.003), and sometimes/always parallel parking (P=0.015). No statistically significant association was observed regarding the other study variables (Table 1) (P>0.05 for all).

Table 2 shows the results of univariate logistic regression measuring the associations between the driving history of the drivers and vehicle and environmental status at the time of the accident with being the at-fault driver. Statistically significant associationswere observed between car collision location (front, $OR_{yes/no}$=2.03, 95%CI: 1.36, 3.02 P<0.001), (left, $OR_{yes/no}$=1.64, 95%CI: 1.08, 2.50 P=0.020) and (right, $OR_{yes/no}$=1.52, 95%CI: 1.01, 2.28 P=0.041), no of tickets issued since 3 years ago ($OR_{3</no\ ticket}$=2.83, 95%CI: 1.55, 5.16), the reason for tickets issued ($OR_{driving\ fault/no\ ticket}$=3.60, 95%CI: 1.97, 6.60, P<0.001), no traffic accidents within

Table 1: Univariate analysis of the demographic and behavioral characteristics of the participants

Variable	Characteristics	At-fault-drivers N (%)	Not-at-fault drivers N (%)	OR	95% CI	P value
Age	Median (Q1,Q3)	32 (25,37)	30 (25,36)	1.05	0.98-1.02	0.555
Score	Median (Q1,Q3)	7 (6,8)	8 (7,9)	0.85	0.75-0.95	0.007
Gender	Male	183 (91.5%)	184 (92.0%)	1	0.46-1.90	0.856
	Female	17 (8.5%)	16 (7.0%)	0.93		
Job	Employed/student Unemployed	41 (20.5%)	48 (24.0%)	1		
	Self-employed	120 (60.0%)	128 (64.0%)	1.09	0.67-1.78	0.707
	Driver	39 (19.5%)	24 (12.0%)	1.90	0.98-1.67	0.055
Marital status	Married	102 (51.0%)	95 (47.5%)	1	0.58-1.28	0.484
	Single/divorced	98 (49.0%)	105 (52.5%)	0.86		
Education	Diploma<	64 (32.0%)	60 (30.0%)	1		
	Diploma	87 (43.5%)	92 (46.0%)	0.95	0.56-1.62	0.871
	<Diploma	49 (24.5%)	48 (24.0%)	0.60	0.56-1.40	0.887
Perceived income	Good	33 (16.5%)	25 (12.5%)	1		
	Moderate	94 (47.0%)	105 (52.5%)	0.45	0.42-1.46	0.790
	Low	73 (36.5%)	70 (35.0%)	0.19	0.37-1.22	0.678
Alcohol use	No	150 (75.0%)	174 (87.0%)	1	1.32-3.75	0.003
	Yes	50 (25.0%)	26 (13.0%)	2.23		
Keeping distance from the front vehicle	Important	159 (79.5%)	171 (85.5%)	1	0.90-2.56	0.116
	Not important	41 (20.5%)	29 (14.5%)	1.52		
Over speed	Never	37 (18.5%)	57 (28.5%)	1		
	Sometimes	104 (52.0%)	115 (57.5%)	1.39	0.85-2.27	0.186
	Always	59 (29.5%)	28 (14.0%)	3.24	1.76-5.98	<0.001
Mobile use	Never	78 (39.0%)	77 (38.5%)	1		
	Occasionally	55 (27.5%)	69 (34.5%)	1.22	0.49-1.26	0.322
	Always/ringing	67 (33.5%)	54 (27.0%)	1.01	0.76-1.97	0.405
Spiral movement	Never	140 (70.0%)	159 (79.5)	1		
	Sometimes	38 (19.0%)	35 (17.5%)	1.23	0.73-2.05	0.423
	Always	22 (11.0%)	6 (3.0%)	4.16	1.64-10.56	0.003
Parallel parking	Never	73 (36.5%)	97 (48.5%)	1	1.09-2.44	0.015
	Sometimes/Always	127 (63.5%)	103 (51.5%)	1.63		
Using turn signal	Never/Sometimes	41 (20.5%)	37 (18.5%)	1	0.53-1.44	0.614
	Always	159 (79.5%)	163 (81.5%)	0.88		
Contravening red traffic light	Never	157 (78.5%)	160 (80.0%)	1	0.82-1.94	0.276
	Sometimes/always	43 (21.5%)	40 (20.0%)	1.26		
Wearing seat belt	Never	55 (27.5%)	53 (26.5%)	1		
	Sometimes	53 (26.5%)	63 (31.5%)	0.81	0.47-1.37	0.433
	Always	92 (46.0%)	84 (42.0%)	1.05	0.65-1.70	0.825
Contravening zebra crosswalk	Never/ Sometimes	135 (67.5%)	145 (72.5%)	1	0.82-1.94	0.276
	Always	65 (32.5%)	55 (27.5%)	1.26		

3 years ($OR_{2=</no\ accidents}$=2.47, 95%CI: 1.49, 4.11 P<0.001), time since the last accident ($OR_{<2\ years\ ago/no\ accidents}$=2.51, 95%CI: 1.55, 4.08, P<0.001), cause of the last accident ($OR_{driving\ fault/no\ accidents}$=2.06, 95%CI: 1.36, 3.12, P=0.001), and cause of the current accident ($OR_{driving\ fault/other\ fault}$=0.45, 95%CI: 0.23, 0.88, P=0.020). However, no statistically significant association was observed in terms of vehicle refinement frequency, vehicle cleanliness, and replacing defective headlights with being an at-fault driver (P>0.05 for all).

Table 3 shows the results of multiple logistic regression. Based on the results, driving wth highspeed ($OR_{yes/no}$=2.41, 95%CI: 1.25, 4.63, P=0.008), having a history of accident within the recent two years ($OR_{yes/no}$=1.87, 95%CI: 1.11, 3.14, P=0.017), and receiving traffic ticket (due to speed, overtaking) (OR=3.38, 95%CI: 1.75, 6.49, P<0.001) were significantly associated with the risk of being an at-fault driver in a fatal/injurious car accident.

Figure 1 shows the ROC curve in the model prediction. The area under the curve (AUC) value, sensitivity, and specificity of the model were 0.716 (95% CI: 0.666-0.765), 0.82, and 0.51, respectively. The AUC value indicates that the regression model has an acceptable prediction value.

Discussion

Previous studies conducted on driving behaviors affecting traffic accidents have stated that gender influences high-risk driving, as male drivers are more prone to be engaged in high-risk driving behaviors than female drivers.[17, 18] Age is another important factor that can affect high-risk driving behaviors.[17]

Table 2: Univariate analysis of the characteristics of the participants and driving history

Variable	Characteristics	Case-driver N (%)	Control-drive N (%)	OR	95% CI	P value
Driving history(years)	Median (Q1,Q3)	10 (6,16)	10 (6,15)	1.00	0.98-1.02	0.866
Daily driving (hrs/day)	Median (Q1,Q3)	3 (2,5)	2 (1,5)	1.02	0.96-1.08	0.423
Driving license issued	<5 years	59 (29.5%)	56 (28.0%)	1		0.740
	>=5 years	141 (70.5%)	144 (72.0%)	0.92	0.60-1.43	
No of collisions	0-1	139 (69.5%)	155(77.5%)	1		0.071
	>=2	61 (30.5%)	45 (22.5%)	1.51	0.96-2.36	
Front collisions	No	84 (42.0%)	119 (59.5%)	1		<0.001
	Yes	116 (58.0%)	81 (40.5%)	2.03	1.36-3.02	
Back collision	No	162 (81.0%)	164 (82.0%)	1		0.797
	Yes	36 (18.0%)	38 (19.0%)	1.06	0.64-1.77	
Right collision	No	112 (56.0%)	132 (66.0%)	1		0.041
	Yes	88 (44.0%)	68 (34.0%)	1.52	1.01-2.28	
Left collision	No	122 (61.0%)	144 (72.0%)	1		0.020
	Yes	78 (39.0%)	56 (28.0%)	1.64	1.08-2.50	
No of tickets issued in the last 3 years	No ticket	40 (20.0%)	74 (37.0%)	1		
	1-3	114 (57.0%)	96 (38.0%)	2.19	1.37-3.51	0.001
	>3	46 (23.0%)	30 (15.0%)	2.83	1.55-5.16	0.001
Why tickets issued	No ticket	18 (9.0%)	45 (22.5%)	1		
	Driving fault	140 (70.0%)	97 (48.5)	3.60	1.97-6.60	<0.001
	Other faults	42 (21.0%)	58 (29.0%)	1.81	0.92-3.55	0.085
No of traffic accidents within 3 years	0	84 (42.0%)	122 (61.0%)	1		
	1	58 (29.0%)	44 (22.0%)	1.91	1.18-3.09	0.008
	>=2	58 (29.0%)	34 (17.0%)	2.47	1.49-4.11	<0.001
Time since the last accident	No accident	63 (31.5%)	96 (48.0%)	1		
	<2 years	76 (38.0%)	46 (23.0%)	2.51	1.55-4.08	<0.001
	2-5 years	48 (24.0%)	40 (20.0%)	1.82	1.08-3.09	0.025
	>5 years	13 (6.5%)	18 (9.0%)	1.10	0.50-2.40	0.810
Cause of the last accident	No accident	63 (31.5%)	96 (48.0%)	1		
	Driving fault	126 (63.0%)	93 (46.5%)	2.06	1.36-3.12	0.001
	Other causes	11 (5.5%)	11 (5.5%)	1.52	0.62-3.72	0.356
Replacing defective headlights	Immediately	164 (82.0%)	164 (82.0%)	1		
	In free time	36 (18.0%)	36 (18.0%)	1.00	0.60-1.66	0.999
Car cleanliness	Dirty	30 (15.0%)	23 (11.5%)	1		
	Often clean	146 (73.0%)	163 (81.5%)	1.57	0.38-1.23	0.210
	Always clean	24 (12.0%)	14 (7.0%)	0.39	0.55-3.08	0.531
Collision with	Car/bus	98 (49.0%)	91 (45.5%)	1		
	Motorcycle	59 (29.5%)	84 (42.0%)	0.65	0.42-1.01	0.056
	Pedestrian	43 (21.5%)	25 (12.5%)	1.59	0.90-2.82	0.107

Table 3: Multivariate analysis of the association of the study variables with being an at-fault driver in a fatal/injurious car accident

Characteristics	OR	95%CI	P value
Why tickets issued			
No ticket	1		
Speeding-overtake	3.38	1.75, 6.49	<0.001
Other reasons	1.82	0.88, 3.75	0.103
Time since the last accident			
No accident	1		
<2 years	1.87	1.11, 3.14	0.017
2-5 years	1.50	0.86, 2.61	0.148
>5 years	1.07	0.47, 2.44	0.863
Speeding			
Never	1		
Sometimes	1.01	0.59,1.71	0.964
Always	2.41	1.25, 4.63	0.008

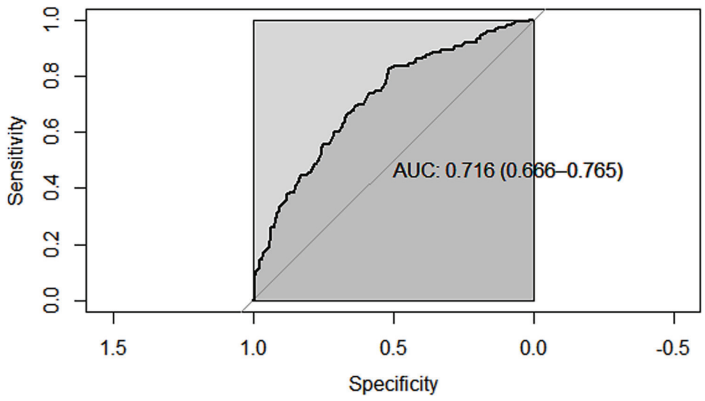

Figure 1: Receiver-operating characteristic curve (ROC curve).

Studies have suggested that younger age and less driving experience are two important driver's related risk factors for severe accidents.[19-21] In addition to gender and age, factors such as alcohol or drug use,[22, 23] education,[21] and salary[24] are also mentioned as contributing factors in severe accidents. The current case-control study was conducted to investigate and identify various factors affecting the incidence of injurious and fatal traffic accidents among Iranians (drivers in Shiraz, the capital of Fars province). For this purpose, we interviewed 400 drivers (200 as the at-fault drivers and 200 as the not-at-fault drivers). The unadjusted results suggested that drivers with a history of parallel parking and spiraling, those with a history of refinement of the front, left, and right of their car, as well as drivers with more than one accident or ticket in the last three years, had a higher risk for being an at-fault driver in an injurious/fatal car accident. According to the results controlled for other variables, driving at high speed, history of traffic tickets due to driving faults (high speed and overtaking), and history of car crashes within the past two years can significantly predict the risk of fatal and injurious traffic accidents caused by a driver.

The results of our study showed that driving at high speeds increased the risk of being an at-fault driver in the fatal and injuries accidents. Our result was consistent with that of another study conducted by Al-Thaifani and Bakhtiyari, suggesting high speed as the most important cause of severe and fatal accidents.[25, 26] Also, studies in China reported that human error could account for 92 percent of all road deaths in the country and speeding was one of the most common contributing factors for fatal traffic accidents.[27, 28] This is because increasing the speed of the vehicle, whether due to ignorance or overconfidence, can make the car difficult to be controlled by the drivers in due time.[29] As a result, braking in emergencies cannot prevent an accident.

According to the results of this study, drivers with a history of traffic tickets due to driving errors such as speeding and overtaking have a higher risk of being an at-fault driver in injurious accidents. Our result is consistent with those of Jørgenrud's study, suggesting that people with a history of high-speed tickets were more likely to be involved in traffic accidents.[20] Also, a study showed that those who had previous driving offenses were at greater risk for future offenses, and having a serious offense during one year of driving almost doubled the likelihood of commencing further serious offenses in the subsequent year.[30] Other studies also stated that increasing the number of driving offenses per year or receiving a driving ticket during the previous 12 months increased the probability of being involved in a fatal or severe accident.[31, 32] Our finding is, however, inconsistent with the reports suggesting that speed ticket policy is associated with a reduction in being involved in severe and fatal accidents.[33, 34] This discrepancy is possibly due to the fact that law enforcement and fining policy in Iran is not adequately preventive of driving offenses.[32]

Based on the results of our study, having a history of an accident less than two years before the current accident increases the risk of being involved in a serious car accident as the at-fault driver. This result is consistent with those of other studies that reported an increased risky driving behavior in relation to having a history of accidents in the past year.[24, 30, 35, 36] For example, drivers with a history of car accidents are more likely to take the risk of dangerous driving or other high-risk behaviors such as speeding offenses.[37, 38] The result is, however, inconsistent with what was reported by Ngueutsa and Kouabenan in Cameroon and Weinstein who noted that being involved in a road accident reduces the possibility of subsequent risky driving, and drivers who had been involved in accidents tended to fear traffic risks more than did those who had not.[39, 40] The result of ROC analysis suggested that the final model can detect high-risk drivers with acceptable accuracy.

Strength and Limitation

Strong points: The strength of this study was the inclusion of all the factors related to traffic accidents, including environmental, human, and vehicle factors with an emphasis on human behavior and a person's driving history, by asking the driver.

Limitation: In our study, the data were collected by interviewing the drivers involved in fatal or injurious traffic accidents. Due to the anonymity of the participants, we had no access to the official data of the drivers, and it was not possible to link the driver's responses to the legal file data to confirm the self-reported data.

Conclusion

The results of our study show that a combination of a few risk factors including driving at high speed, a history of receiving traffic tickets due to speeding and overtaking, and a history of accidents within the last two years can be used to screen-out Iranian high-risk drivers who will probably be involved in serious car accidents. It seems that certain driving behaviors are the major causes of serious traffic accidents in Iran. Therefore, intervention measures such as identifying high-risk drivers (detectable with few observable driving behaviors and police data) and providing them with training programs are possible effective actions to reduce the fatality of car accidents in Iran.

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Authors Contribution

Conceptualization: Masumeh Daliri, Mohammad Fararouei, Methodology: Masumeh Daliri, Mohammad Fararouei.; Software: Masumeh Daliri, Mohammad Fararouei.; Validation: Masumeh Daliri, Hesamuddin Taheri, Mohammad Fararouei.; Formal analysis: Masumeh Daliri, Mohammad Fararouei.; Investigation Masumeh Daliri, Hesamuddin Taheri, Mohammad Fararouei.; Resources: Masumeh Daliri, Hesamuddin Taheri, Mohammad Fararouei.; Data Curation: Masumeh Daliri, Mohammad Fararouei.; Writing (original draft): Masumeh Daliri, Hesamuddin Taheri, Mohammad Fararouei.; Writing (review & editing): Masumeh Daliri, Hesamuddin Taheri, Mohammad Fararouei.; Visualization Masumeh Daliri, Mohammad Fararouei.; Supervision, Mohammad Fararouei

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Institutional Review Board Statement

The study was conducted in accordance with the Declaration of Helsinki and approved by Ethics Committee of Shiraz University of Medical Science. (Protocol code IR.SUMS.REC.1400.787, date of approval: 2022-01-19).

Conflict of Interest: None declared.

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ORIGINAL ARTICLE

Socio-economic Inequality of Outpatient and Inpatient Healthcare Services: A Cross-sectional Study in Iran

Parisa Naseri[1], MSc;
Bahman Ahadinejad[2], PhD;
Mohammad Amerzadeh[2], PhD;
Fariba Hashemi[3], MSc;
Sima Rafiei[2], PhD

[1]Student Research Center, Qazvin University of Medical Sciences, Qazvin, Iran
[2]Social Determinants of Health Research Center, Research Institute for Prevention of Non-Communicable Diseases, Qazvin University of Medical Sciences, Qazvin, Iran
[3]School of Paramedicine, Qazvin University of Medical Sciences, Qazvin, Iran

Correspondence:
Sima Rafiei, PhD;
School of Public Health, Qazvin University of Medical Sciences, Bahonar Blvd., Qazvin, Iran
Tel: +98 9123886817
Email: sima.rafie@gmail.com
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Abstract

Background: Ensuring equal utilization of health services has always been a priority in health systems globally. Iran implemented reforms such as the Health Transformation Plan (HTP), in which one objective was to reduce inequity in access to inpatient and outpatient services. These studies aimed to measure inequality in health services utilization in Qazvin, Iran, and clarify inpatient and outpatient utilization patterns among socioeconomic subgroups of the population.

Methods: This cross-sectional study recruited 442 households living in Qazvin, Iran, in 2019. We collected data using a tool that included demographic characteristics, socioeconomic status, and health services utilization. We applied the concentration index to measure inequality and performed data analysis using STATA 15.

Results: Based on our estimates, the utilization rates of outpatient and inpatient services in the study sample were 0.89±1.39 and 0.45±0.94, respectively. There was no statistically significant difference in the use of outpatient healthcare services in terms of gender and insurance coverage of the households, while literacy, age, and health condition had statistically significant effects on inpatient healthcare utilization ($P<0.05$). Furthermore, the marginal effects of age and literacy on the utilization of outpatient services were statistically significant ($P<0.05$), so that literacy and aging increased the outpatient HSU. Except for age, the marginal effects of other characteristics on the utilization of inpatient services were statistically significant ($P<0.05$).

Conclusion: Our findings indicated that inequality in healthcare utilization reduced over time, showing that in addition to reducing inequality in HSU, population groups with lower socio-economic status have benefited more from both inpatient and outpatient services.

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Keywords: Inequality, Concentration index, Socioeconomic status

Introduction

One important principle in the Universal Health Coverage (UHC) model is equitable access to healthcare services for people without suffering from economic hardship.[1] Sustainable Development Goals (SDG) have also re-emphasized this key issue to ensure healthy lives and well-being promotion for all ages.[2] The Iranian health system also launched a series of reforms to ensure the availability and accessibility of required healthcare services for all.[3] Health equity is defined as reducing and eliminating health disparities and related determinants that negatively influence marginalized or excluded groups.[4] On the other hand, health inequity is

a particular type of health inequality that indicates an unfair disparity in health. When health discrepancies are avoidable, inappropriate policies let them maintain inequity.[5] Unequal access to healthcare services could decline health outcomes and increase morbidity and mortality among different population groups.[6]

To improve health equity, Iran increased the government health expenditure from 171.6 to 673.6 dollars over 15 years.[7] It also established the primary healthcare network and Universal Health Insurance (UHI) Act as healthcare reforms to achieve the purpose.[8] Although health inequity is a global issue, the impact of different social factors on health has been revealed to be different among various countries. For example, a study conducted in European nations found much less difference in mortality between the two population groups with high and low education in Spain, while a significant difference was reported between these two population groups in the Czech Republic.[9]

The World Health Organization (WHO) has also recognized health equity as an important issue and formed the Commission on Social Determinants of Health in 2005 to gather global evidence on social determinants of health and accordingly recommend practical actions to address health inequalities.[10] Focusing on the impact of socioeconomic factors on health inequality allows health policy makers to identify current health disparities in a cultural context and provide necessary insights into how social status, income, occupation, and educational level lead to health outcome differences.[11, 12]

In Iran, despite the progress in the public health status in recent years, the health disparities due to gender differences, economic pressures, occupation, and cultural and educational status are quite evident.[13] In fact, the socioeconomic status, and other social factors were mentioned as the indicators of health equity in Iran.[14, 15] Literature also signified the role of eliminating inequalities in social groups as a key prerequisite for equity in health.[15]

Several studies have been conducted through decomposition analysis of the concentration index due to the importance of the issue. They used the concentration index (CI) to measure outpatient and inpatient economic inequality on a concentration curve. The curve is made of a two-dimensional plot of horizontal and vertical axes in which the household health status is examined about different economic status groups. In the case of equity in the health distribution among different groups, the equity line forms a 45-degree angle, while placing the curve above the equity line indicates a greater concentration of health in people with lower socioeconomic status.[16, 17] A study examining health services utilization (HSU) among women in one of the western Iranian districts indicated an unequal distribution influenced mainly by socioeconomic factors. Female-headed families whose husbands were lost due to death or divorce had more vulnerability to poverty, resulting in worse health status.[18] Literature also emphasized the importance of race/ethnicity, parent income, parent education, culture, and healthcare access as key determinants of HSU.[19] Understanding the factors related to disparities in health services utilization, particularly those resulting from inequitable access to health services can provide useful evidence for policymakersto plan more effectively with the aim to reduce undesirable conditions.[20] Most of the studies acknowledged that a decline in health consequences and a rise in health inequity would result in crucial side effects on the workers' productivity and reduce gross domestic product.[21] Such information can act as a valuable guide for policymakers and evidence-based decision-making for health planning. Therefore, studying socio-economic inequity in health services utilization could fill the research gaps and help policymakers to provide supportive services. A study conducted by Kazemi-Karyani revealed that the highest socioeconomic inequity value was in Qazvin province, emphasizing the necessity for policy interventions.[22] Qazvin is in the northwest of Iran with 1.2 million people by the 2016 census. The literacy rate was over 82%, and gender disposition was 50.7% men to 49.3% women.[14] The main purpose of this study was to investigate inequity determinants in health services utilization among households living in Qazvin city.

Methods

Study Design and Setting

We conducted a cross-sectional study among residents living in Qazvin city, Iran, in 2019.

Population and Sample Size, Sampling Procedure

The target population included clients of urban public healthcare centers who had utilized inpatient or outpatient healthcare services during the past 12 months. We included all individuals aged 18 to 90 years who agreed to participate in our study. Using formula [n=P (1-p) 2 z2/d2] and assuming P=0.5, z=1.92, d=0.05, the estimated sample size was 368. After considering a 20% loss, the sample size turned out to be 442. We determined the share of each center in the sample size based on the percentage of the total number of clients of each center.

Measures

The data collection tool was a structured questionnaire that encompassed three sections. Section one contained 12 demographic questions. Section two included 19 questions about households' accessibility to inpatient, outpatient, and diagnostic health services. The last section consisted of seven

questions in terms of the population's socio-economic status.[23] In this study, the main outcome variables were outpatient and inpatient healthcare utilization provided by public providers. The outpatient health care utilization was measured by asking the question "Have you used any outpatient care (including emergency care, outpatient visits, clinical laboratory tests, and other diagnostic procedures) during the last year?" The latter variable was also measured by asking the question "Have you received any inpatient care (for example being admitted to the hospital and hospitalized more than 24 hours) in the last 12 months?" We used demographic and socio-economic status variables (SES) as independent factors in our analysis. Accordingly, age, gender, education (illiterate/literate), basic health insurance (no health insurance/ have health insurance), health condition (no illness, have an illness), household size, and income were considered as independent factors. The validity of the questionnaire has been confirmed in similar research, such as Ranjbar et al.[18] We tested the reliability of the questionnaire by the test-retest method. At first, the researcher randomly provided the questionnaire to 30 individuals who were part of the research community, and after two weeks, the participants were again asked to answer the questionnaire. Then, Cronbach's Alpha coefficient was calculated to be 0.87 which ensured the reliability of the questions.

Data Collection

First, we obtained the approval of the Ethics Committee of the Qazvin University of Medical Sciences (IR.QUMS.REC.1398.061). Then, the researcher provided the questionnaire to the clients of health centers (according to the number of samples calculated for each center with the mentioned formula) and resolved the ambiguities of the respondents with the necessary instructions about the questionnaire. If a respondent was illiterate an interview was applied so that the questioner asked questions and recorded the exact answers of the respondent.

Data Analysis

First, we entered the collected data into the STATA 11 (Stata Corp LP, College Station, TX, USA) for statistical analysis and performed all descriptive and inequality analyses using this software. We also used the Concentration index (CI) using a Lorenz curve to measure outpatient and inpatient economic inequality.[24] The health status and economic condition were depicted on a two-dimensional plot, determining the households' health status in different economic statuses. When utilization of health services among all socio-economic subgroups had an equal distribution, the equity line formed a 45-degree angle. Placing the curve above the equity line meant the concentration of health in people with low socio-economic status.[25] We analyzed data descriptively using frequency counts and percentages for categorical variables and the mean and standard deviation (SD) for continuous variables. We then constructed Poisson regression models to estimate the parameters specified in the model. The research team chose the Poisson model to identify the factors with the most significant influence on inequality as it is a probability model for count variables. These variables are those pieces of count data that are often treated as a random variable, the poisson, binomial, and negative binomial distributions to represent the distribution.[26] Further, we considered a P value less than 0.05 to be statistically significant.

Results

Table 1 shows that most of the participants (92.5%) were from male-headed households, and the rest were female-headed households (7.5%). The mean age of the participants was 36.6±12.9 years, and 77% had pre-academic education. 78.1% had health insurance coverage, and the average household size was 3.85±1.1. The utilization rates of outpatient and inpatient services in the study sample were 0.89±1.39 and 0.45±0.94, respectively.

Table 2 shows the comparison of the average utilization of inpatient and outpatient care services

Table 1: Demographic and socioeconomic characteristics of the households (n=442, Income based on Iran Rial in 2019)

Determinants	Categories	Frequency (%)
Literacy	Illiterate	46 (10.4)
	Literate	396 (89.6)
Insurance coverage	Have	345 (78.1)
	Not have	97 (21.9)
Gender	Male	410 (92.6)
	Female	32 (7.2)
	Mean	SD
Age	36.61	12.99
Household size	3.85	1.11
Income (Rial)	25,196,390	13,429,040
ISU	0.45	0.942
OSU	0.89	1.393

ISU: Inpatient services utilization, OSU: Outpatient services utilization

Table 2: Comparison of the average utilization of inpatient and outpatient services among the study groups

Types of services	Gender			Literacy status			Insurance coverage		
	Female	Male	P	Illiterate	Literate	P	No	Yes	P
ISU	0.46±0.97	0.45±0.86	0.93	0.93±1.9	0.40±0.74	0.06	0.39±0.95	0.47±0.93	0.46
OSU	0.93±1.49	0.81±1.12	0.38	2.09±2.05	1.63±1.44	0.23	1.64±1.26	1.72±1.64	0.73

ISU: Inpatient services utilization, OSU: Outpatient services utilization

Table 3: Concentration indices of healthcare utilization based on socio-economic characteristics

Types of services	Concentration index	Standard Error	P value
ISU-income	-0.045	0.053	0.39
ISU-Literacy status	-0.110	0.055	<0.05
ISU-age	0.155	0.056	<0.05
OSU-Literacy status	-0.033	0.021	0.12
OSU-income	-0.058	0.032	<0.10
OSU-age	0.041	0.035	0.25

ISU: Inpatient services utilization, OSU: Outpatient services utilization

among the population subgroups. As seen, only the utilization of inpatient services had a statistically significant difference between literate and illiterate people (P<0.1).

Table 3 depicts the concentration indices of healthcare utilization for the subgroup analysis in Qazvin. The corresponding concentration curves of inpatient and outpatient based on different subgroups are shown in Figures 1-6. Except for the concentration index of age, the concentration index of other socio-economic characteristics was negative. It should be noted that regarding the inpatient services utilization, only the indices of literacy and age of the households were statistically significant (P<0.05).

Figures 1-6 illustrate the concentration curve of inpatient and outpatient utilization based on the income, literacy level, and age of the household heads. As can be observed, the distribution of inpatient and outpatient services utilization based on the head's income and distribution of outpatient services utilization based on the head's literacy level were approximately 45 degrees tangential. On the other hand, concentration curves for the utilization of inpatient and outpatient services based on age were shown to be below 45°. It is noteworthy that Q shows the cumulative share of the use of healthcare services.

Table 4 shows Pearson correlation coefficients between explanatory variables and the utilization of health care services. As shown, some of the explanatory variables had statistically significant correlations with utilization. However, because some other non-significant variables have been identified as influential factors in the literature, we also included them in the model.

The Poisson regression shows marginal effects of age, income, gender, household size, and the literacy of households on the utilization of outpatient and inpatient services (Tables 5 and 6). As shown, the marginal effects of age and literacy on the utilization of outpatient services were statistically significant (P<0.05). Except for age, the marginal effects of other characteristics on the utilization of inpatient services were statistically significant (P<0.05).

Discussion

This study aimed to determine the pattern of inpatient and outpatient HSU among different socioeconomic subgroups of the population in Qazvin, Iran, to measure inequity in health services utilization. The study findings revealed that HSU was more among the population with lower socio-economic status (SES), those in higher age groups, and those having chronic or contagious disease during the last 12 months.

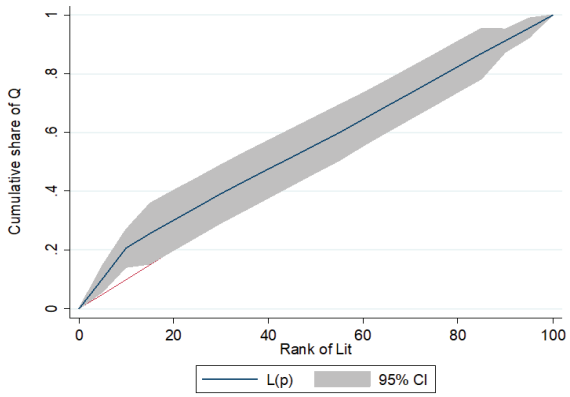

Figure 1: Concentration Index (CI) of inpatient Health Service Utilization (HCU)-educational status

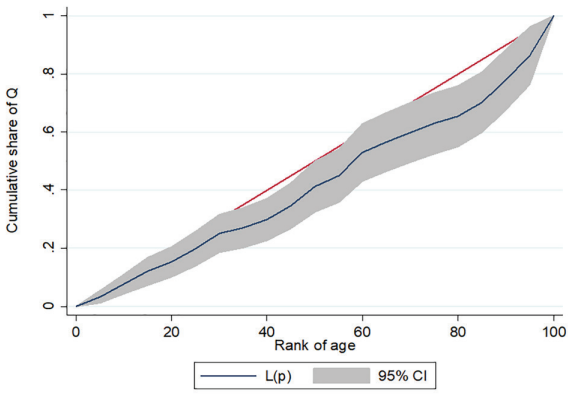

Figure 2: CI of inpatient HCU-age

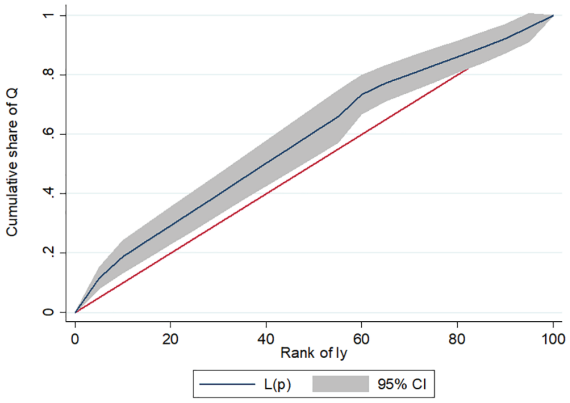

Figure 3: CI of outpatient HCU-economic status

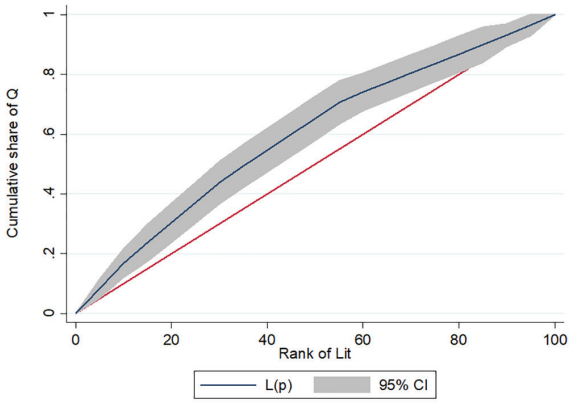

Figure 4: CI of outpatient HCU-educational status

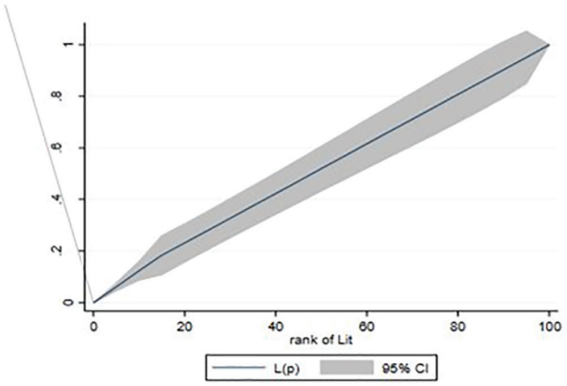

Figure 5: Concentration curve of outpatient services utilization (Q) based on the literacy level

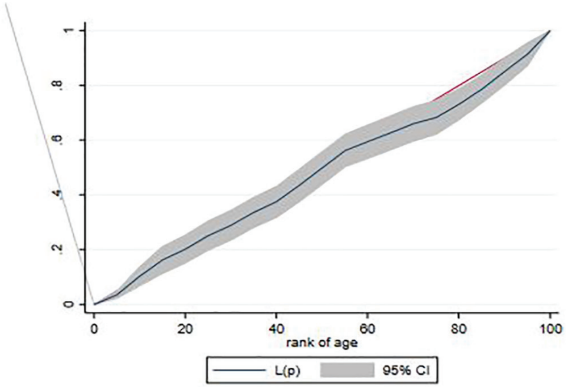

Figure 6: Concentration curve of outpatient services utilization (Q) based on the age

Table 4: Pearson correlation coefficients between explanatory variables and healthcare services utilization

Types of services	Age	Income	Literacy	Insurance coverage	Gender	Illness	Household size
ISU	0.157*	-0.061	-0.174*	0.035	-0.046	0.647*	-.004
OSU	0.138*	-0.138*	-0.220*	-0.048	-0.041	0.579*	-.099

*Significance at the 5%, ISU: Inpatient services utilization, OSU: Outpatient services utilization

Table 5: Poisson regression of outpatient services utilization based on explanatory variables (marginal effects)

Explanatory variables	dy/dx	Robust Standard Error	Z-value	P value
Age	0.006	0.002	-2.71	0.007
Income	-0.003	0.000	-1.23	0.221
Literacy*	-0.149	0.021	-7.16	0.001
Household size	0.030	0.026	-1.15	0.250
Illness*	1.34	0.104	12.84	0.001

(*)dy/dx is for discrete change of dummy variable from 0 to 1, Reference group=Healthy & Illiterate; N=442, Wald chi^2 (5)=208.82, P>chi^2=0.001, Log pseudo likelihood=-454.281

Table 6: Poisson regression of inpatient services utilization based on explanatory variables (marginal effects)

Explanatory variables	dy/dx	Robust SE	Z	P value
Age	2	0.9	-0.22	0.26
Income	-0.0002	0.000	-2	0.004
Literacy*	-0.246	0.053	-4.60	0.001
Household size	-0.046	0.010	-4.42	0.001
Illness*	0.954	0.017	55.53	0.001

(*) dy/dx is for discrete change of dummy variable from 0 to 1, Reference group=Healthy & Illiterate; N=442, Wald chi^2(5)=346.38, P>chi^2=0.001, Log Pseudo likelihood=-247.41

Considering that the study subjects were selected from the clients of public health centers and since most of them were from the middle and lower than average income deciles, it is expected to observe an inverse relationship between economic status and the utilization of healthcare services. In fact, in countries where access to healthcare services and hospitalization is free of charge, people with lower SES receive more

outpatient services and are hospitalized more than those with higher SES.[27-30] Several studies were in line with our findings, including research conducted by Hidayat (2004) and a study among 758 households in Markazi Province which stated that HSU was more among the population with lower socioeconomic status. The studies also added that people with lower SES suffer from poorer health conditions which simply explains the reason for the higher utilization rate among people with lower SES.[15, 31] Furthermore, when the health system in a country is mainly public the same as in Iran, people with lower SES are more able to have access to both inpatient and outpatient care services provided in public healthcare facilities.[23] Similarly, Vahedi et al. mentioned economic status as a main contributing factor in reducing inequality in inpatient care utilization. Thus, providing healthcare services through the active engagement of the public sector could eliminate most of the socio-economic inequalities and improve appropriate access to healthcare services.[6] This is in the same line with the findings of Leung et al.'s study conducted in Hong Kong, where public health services were mainly used by the less wealthy population due to tax-based health financing and managerial mechanisms applied to support the utilization of public healthcare services among the less well-off.[32]

Some studies also mentioned gender, place of residence, and insurance coverage as the main factors influencing inequity in HSU.[11, 12, 26] In comparison, subgroup analysis in our study revealed no significant HSU inequality regarding gender and individuals' health insurance coverage. Such differences might be due to various methods employed in different studies, both in terms of inequity investigation and the construction of socioeconomic status. In addition, the low contribution of health insurance coverage in our study might be explained by the establishment of healthcare reforms such as the primary healthcare network and Universal Health Insurance Act which facilitated the provision of required healthcare services to the population with different SES.[26]

The CI of inpatient HSU regarding educational status was equal to -0.1105 and the C indices of outpatient HSU regarding both educational and economic status were respectively -0.192 and -0.0162. From the obtained data, it can be concluded that the size of inequality in HSU in Qazvin is insignificantly different. Therefore, the overall outpatient and inpatient care utilization was not considerably different among people with different socioeconomic classes. Perhaps, the main reason for this reduction of inequality over the past few years is the establishment of the Health Transformation Plan (HTP) in 2014 which led to extended health insurance coverage and accessibility to health services among the Iranian population.[3, 6, 33] HTP has three main objectives, including equity in access to health services, improvement in the quality of the provided services, and financial support of the population against the economic burden of health services. Out of the seven policy packages of this program, four are directly related to reducing inequity and providing financial support for the population against high healthcare expenditures.[3, 33] In this regard, the results of several studies conducted in Iran and Turkey affirmed that after implementing HTP, a considerable reduction in out-of-pocket occurred.[33, 34] Mohammadbeigi et al. revealed similar results and emphasized the vital role of primary healthcare services, which increased individuals' access to health services and decreased inequity, especially among the poor population.[26]

Limitations of the Study

First, the analysis was based on self-reported data, which was subject to reporting bias. Second, we did not ask any standard questions about health status, such as health-related quality of life and participants' self-rated health. Therefore, the degree of health inequality may change if suitable need variables are considered in the analysis. Finally, due to insufficient sample size, we could not estimate the marginal effect of determinants by socio-economic subgroups.

Conclusion

Our findings revealed that the concentration of inpatient HSU was among people with lower educational status and older people. Furthermore, regarding the outpatient HSU, concentration was among households with lower economic and educational status and those suffering from illness. Thus, we recommend that inequality in healthcare utilization should reduce over time, indicating that in addition to reducing inequality in HSU, population groups with lower socio-economic status have benefited more from both inpatient and outpatient services.

Ethics Approval and Consent to Participate

We received approval from the Ethics Committee of the Qazvin University of Medical Sciences (IR.QUMS.REC.1398.061–2019/07/09). We obtained verbal consent from the participants before data collection and after an explanation of the study objectives. We used verbal consent because the data were collected using a self-assessment questionnaire and thus did not involve any human data. The Ethics Committee approved the use of verbal consent. Questionnaires were completed anonymously to ensure confidentiality.

Availability of Data and Material

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

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The authors have not received any research funding for this paper.

Authors' Contribution

SR and PN developed the study protocol and the study design, data collection, interpretation of the findings, and manuscript writing. EK participated in the data collection and revised the manuscript. BA conducted the data analysis and manuscript writing. All the authors read and approved the final draft.

Conflict of Interest: None declared.

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ORIGINAL ARTICLE

Assessment of Nurses' Practice of Standard Precautions in Hospitals of Babil Governorate, Iraq

Mustafa Ali Hasan[1], MSc;
Wissam Abdul-Ameer Ali[2], PhD;
Rajaa Ahmed Mahmoud[3], PhD

[1]Department of Community Health Techniques, College of Health & Medical Technology, Basrah, Southern Technical University, Iraq
[2]Department of Medical Laboratory Technologies, College of Health & Medical Technology, Basrah, Southern Technical University, Iraq
[3]Ministry of Health, Basra Health Directorate, Training and Human Development Center, Iraq

Correspondence:
Mustafa Ali Hasan, MSc;
Department of Community Health Techniques, College of Health & Medical Technology, Basrah, Southern Technical University, Iraq
Tel: +96 477 18378988
Email: mu.alsultani94@gmail.com
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Abstract

Background: Hospital-acquired infection (HAI) is one of the most frequent issues that hospitals are faced with in every country worldwide. Nurses are an essential part of the medical workforce that play a special role in preventing the transmission of infections within hospitals by implementation of infection prevention standard precautions. This study aimed to assess the level of nurses' practice regarding standard precautions.

Methods: 400 nurses from eight hospitals in Babil governorate are included in this cross-sectional study. To assess the knowledge and practice levels, was used an interview questionnaire. SPSS-27 was used to analyze the data collected from September 2022 to March 2023.

Results: Among 400 nurses, the mean age was 29.07 years and a large number of them (43.8%) had a diploma; while most of nurses had less than 5 years of work experience, the main result revealed that 51.5% of them had poor practice regarding standard precautions.

Conclusion: The majority of nurses did not always practice these precautions, so there is a need to hold educational courses and training workshops for nurses to improve their practice of these measures.

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Introduction

A healthcare-associated infection (HAI) is characterized as "an infection that develops in a patient while receiving care in a healthcare facility and was not present at the time of admission or was incubating prior to admission."[1] These conditions not only impact the patients but also present a substantial occupational hazard for healthcare workers (HCWs).[2] Occupational exposure leading to healthcare-associated infections (HAIs) is described as an occurrence where a healthcare worker (HCW) sustains an injury from a sharp object such as a needle or when their skin or mucous membranes come into contact with blood, saliva, or other potentially contagious substances.[3] HCWs face a heightened risk of contracting HAIs in multiple situations within a healthcare environment. These include direct patient care, instrument sterilization, surgical procedures, healthcare waste disposal, and handling patient care items. These scenarios present significant challenges for HCWs in their efforts to prevent the transmission of HAIs.[4] One of the ways to prevent HAIs is implementing standard precautions.[5] Two strategies for managing infections, namely standard precautions (SPs) and transmission-based precautions (TBPs), have been introduced by the World Health Organization (WHO) and the Centers for Disease Control and Prevention (CDC).[6] Implementing SPs is crucial in preventing HAIs and reducing occupational health hazards. These precautions are founded on the principle that all patients, regardless of their apparent symptoms, can potentially harbor infectious agents.[7] These fundamental principles for infection management are designed to protect the healthcare personnel from HAIs.[8] These precautions

encompass a range of measures, including practicing proper hand hygiene; utilizing protective barriers like gloves, masks, goggles, and face shields; safely handling sharp instruments; and appropriately managing patient care equipment. These precautions are regarded as the essential prerequisites for ensuring healthcare safety in any healthcare setting, regardless of the nature or severity of the illness. Transmission-based precautions (TBPs) are implemented when standard precautions alone are inadequate to contain the transmission of infections.[9] Nurses involved in patient care often encounter bodily fluids, blood, and contaminated needles, putting them at an increased risk of exposure to various infectious agents. Consequently, the likelihood of acquiring infections enhances. Therefore, it is crucial for nurses to have knowledge about and actively practice SPs to minimize the occurrence of these infections.[10] Evaluating the knowledge and practice of SPs among HCWs is an essential measure in order to establish and implement an efficient plan for infection prevention and control in any healthcare environment.[11] Certain indications have pointed out that the spread of HAIs might be linked to insufficient knowledge, inappropriate attitudes, and inadequate practice among HCWs.[12] The expected outcome of this study is to bring about a notable influence by highlighting the level of nurses' practice of SPs in their everyday duties. This particular research, being the first of its kind conducted in governmental hospitals in Babil governorate, aimed to address the gap in research on this subject within this specific region, despite the existence of numerous global studies on the topic.

Methods

Study Period

Data collection commenced in September 2022 and finished in March 2023.

Study Design

A descriptive cross-sectional study was conducted.

Study Population

This study was conducted in Babil Governorate, which is located in the center of Iraq, about 80 kilometers southwest of Baghdad, the capital of Iraq. It is estimated that the area of the governorate is about 5,119 km^2, and its population in 2022 was about 2,288,456 people. There are fifteen hospitals in the governorate, where 6051 nurses are working.

Sample Size and Sampling Techniques

Using a simple random method to select eight hospitals, we selected 50% of the hospitals in the governorate. They included Al-Musaib General, Al-Zahraa, Al-Alexsandriay General, Al-Mahawil General, Al-Imam Sadiq Teaching, Al-Hilla Teaching, Al-Noor Paediatric, and Al-Qasim General Hospitals. These hospitals were strategically distributed across the northern, central, and southern regions of the governorate. The current research used an online web-based software called "Raosoft sample size calculator" available at http://www.raosoft.com/samplesize.html to determine the sample size, which was determined to be 400 nurses. The proportional method was used to determine the number of respondents from each hospital. We calculated the ratio of nurses working in each hospital to the total number of nurses across the eight selected hospitals, and then multiplied this ratio by the sample size to obtain the specific number of participants from each hospital. The lists of nursing staff were obtained from the nursing department head of each hospital, and the participants were randomly selected from these lists.

Data Collection Instrument

An interview-structured questionnaire was used. The questions were formulated based on the guidelines provided by the World Health Organization (WHO).[13, 14] The questionnaire was presented to 10 university experts in the area of competence to check the validity of the study instrument.

Data Collection Method

The selected participants were personally approached by the researcher, who provided them with a concise overview. Following a description of the research objective, verbal consent was sought from each nurse before conducting the interview. Data collection involved the use of the interview questionnaire for each participant, with the completion of the questionnaires which lasted about 13 to 15 minutes.

Statistical Analysis

To evaluate the nurses' infection prevention practices, a set of sixteen questions was used. These questions used a Likert scale with three response options: "always", "sometimes", and "never." The scoring procedure involved assigning a score of 3 for "always" responses, 2 for "sometimes", and 1 for "never". Thus, the total score for SPs practice could range from 16 to 48. Based on the mean score, two categories were established for nurse practice: "safe" if the score was above the mean, and "unsafe" if it was equal to or below the mean.[15]

Ethical Consideration

Before the study was conducting and the data collecting, approval was obtained from the ethics research committee at the Southern Technical University/Faculty of Graduate Studies/Basra. Furthermore, official permissions were obtained from

the Babil Health Directorate (Training and Human Development Center) to formally access the hospitals in Babil Governorate. In addition, verbal consent was obtained from the nurses, indicating their voluntary participation after a detailed explanation of the objectives of the study. The nurses were assured that their involvement in the study was entirely voluntary.

Results and Discussion

Table 1 presents the distribution of nurses based on their social and demographic characteristics. The age of the participants varied from 20 to 60 years, with a mean of 29.07±8.95 years. The age group with the highest percentage (28.7%) was between 20 and 23 years, while the age group with the lowest percentage (19%) was between 27 and 30 years. In terms of gender, there was a clear predominance of females, accounting for 65.3% of the participants. Regarding educational levels, the highest percentage (43.8%) of nurses had a diploma, followed by 29.5% who had a secondary degree. The majority of nurses (57.5%) were married, and 75% of them resided in urban areas. Furthermore, the study found that years of work experience ranged from 1 to 40 years, with a mean of 7.19±4.20 years. The highest percentage (58%) of nurses had less than 5 years of work experience, while the lowest percentage (19.5%) had a tenure exceeding 10 years.

In terms of age, the results were in agreement with a cross-sectional study conducted in Hong Kong by, in which a sample of 260 nurses had a mean age of 30.1±5.47 years.[16] Also, this result is consistent with the results of a cross-sectional study of 233 HCWs in Northern Cyprus, which reported that the mean age was 32.95±9.70 years.[17] Regarding gender, the result is consistent with a study done in Jordan, which found that the proportion of females was higher than that of males.[18] Moreover, this result is similar to that of a study done in Brazil and Hong Kong, which reported that 86.2% of the 560 participants were female nurses.[16] As to the educational level, this result is consistent with a study conducted in Cyprus, which reported that 59.2%, 24.5%, and 16.3% of participants held college or undergraduate degrees, high school or less, and university or above, respectively. Also, most of the participants were married (51.1%).[17] The result of another cross-sectional study is inconsistent with those regarding the educational level, which reported that 70.7% of participants held bachelor's degrees, while the finding of a similar study is consistent regarding marital status, which reported that the highest percentage of participants (63.3%) were married.[19] On the contrary, another study done in Saudi Arabia revealed that a higher percentage of participants (45.3%) held bachelor's degrees.[20] Regarding the years of experience, a cross-sectional study conducted in Hong Kong agreed with our results, which reported that nurses' work experience was 8.0±5.85 years.[16] In Iraq, a study found that the highest percentage (79.4%) of nurses had a work experience less than 5 years.[21]

Table 2 shows the distribution of nurses according to their responses about their practice of SPs. Among the participating nurses, 66.8% reported they always applied SPs during the care of all patients, regardless of their diagnosis and perceived infection status. This finding is consistent with that of a study conducted in Ghana, which found that 50% of HCWs always used the recommended precautions to protect themselves from bodily fluids of all patients.[22] However, only 40.8% reported they always washed their hands before wearing gloves and 84.8% after removing gloves.

Table 1: The distribution of nurses according to sociodemographic characteristics

Variables	Category	Frequency	Percentage %
Age	20-23	115	28.7
	24-26	112	28
	27-30	76	19
	31+	97	24.3
	Mean±SD (Range)	29.07±8.95 (20-60)	
Gender	Male	139	34.8
	Female	261	65.3
Educational level	Secondary graduate	118	29.5
	Diploma graduate	175	43.8
	Bachelor degree or above	107	26.8
Marital Status	Single	152	38
	Married	230	57.5
	Divorced	13	3.3
	Widowed	5	1.3
Residence	Rural	100	25
	Urban	300	75
Work Experience	<5 year	232	58
	5-10 year	90	22.5
	>10 year	78	19.5
	Mean±SD (Range)	7.19±4.20 (1-40)	

Table 2: Distribution of the study population according to their responses about their practice of SPs

Items	Responses	N (%)
Do you apply SPs during the care of all patients, regardless of their diagnosis and perceived infection status?	Always	267 (66.8%)
	Sometimes	128 (32%)
	Never	5 (1.3%)
Do you wash your hands before wearing gloves?	Always	163 (40.8%)
	Sometimes	196 (49%)
	Never	41 (10.3%)
Do you wash your hands after removing gloves?	Always	339 (84.8%)
	Sometimes	50 (12.5%)
	Never	11 (2.8%)
Do you wash hands immediately after contacting any blood or other body fluids?	Always	346 (86.5%)
	Sometimes	46 (11.5%)
	Never	8 (2%)
Do you Wash hands with soap before patient care?	Always	221 (55.3%)
	Sometimes	162 (40.5%)
	Never	17 (4.3%)
Do you Wash hands with soap after patient care?	Always	330 (82.5%)
	Sometimes	55 (13.8%)
	Never	15 (3.8%)
Do you wear gloves when you care for a patient who does not secrete blood or other body fluids?	Always	262 (65.5%)
	Sometimes	105 (26.3%)
	Never	33 (8.3%)
Do you wear protective goggles when caring for a patient to avoid getting blood and other body fluids on your face?	Always	166 (41.5%)
	Sometimes	109 (27.3%)
	Never	125 (31.3%)
Do you wear gown when caring for a patient who poses a risk of blood and other body fluids splashing on your clothes?	Always	226 (56.5%)
	Sometimes	131 (32.8%)
	Never	43 (10.8%)
Do you wear masks when caring for a patient who sneezes or coughs?	Always	320 (80%)
	Sometimes	71 (17.8%)
	Never	9 (2.3%)
Do you recap the used needle before disposal?	Always	310 (77.5%)
	Sometimes	63 (15.8%)
	Never	27 (6.8%)
Do you bend needles before disposal?	Always	155 (38.8%)
	Sometimes	118 (29.5%)
	Never	127 (31.8%)
Do you dispose the used needle and blades in the special sharps' container?	Always	337 (84.3%)
	Sometimes	42 (10.5%)
	Never	21 (5.3%)
Do you close the sharps container and replace it when it is half full?	Always	241 (60.3%)
	Sometimes	118 (29.5%)
	Never	41 (10.3%)
Do you wear gloves when disposing of needle/blades and infectious materials?	Always	264 (66%)
	Sometimes	101 (25.3%)
	Never	35 (8.8%)
Do you wear gloves when you perform injection or drawing blood for patients?	Always	294 (73.5%)
	Sometimes	82 (20.5%)
	Never	24 (6%)

This result is inconsistent with those of a study conducted in Nigeria, which reported that only 2.6% of HCWs washed their hands before wearing gloves and 10.7% did so after removing gloves.[23] The highest percentage of nurses (86.5%) always washed their hands immediately after contacting any blood or other body fluids. This result is slightly higher than that of a study conducted in Ethiopia, which reported that 60% of HCWs often washed their hands after exposure to body fluids.[24] Moreover, the percentage of nurses who always washed their hands with soap before patient care (55.3%) was less than that of the nurses who always washed their hands with soap after patient care (82.5%). This result is consistent with that of a study conducted in Saudi Arabia, which revealed that 59.9% of HCWs washed their hands before patient care.[20] Most nurses wore gloves when they cared for a patient who did not secrete blood or other body fluids (65.5%). This in agreement with the findings of the study conducted in Hong Kong, which found

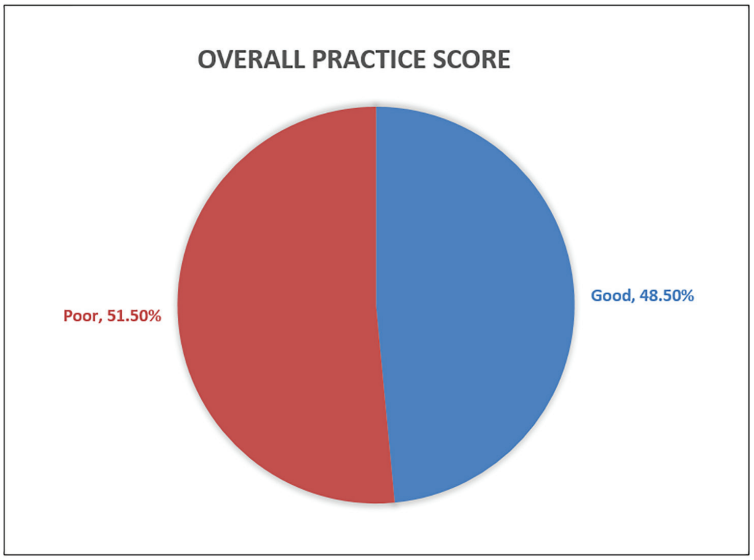

Figure 1: The overall practice score

that 80% of nursing staff wore gloves when exposed to any excretion of patients.[16] However, only 41.5% of nurses wore protective goggles when caring for a patient to avoid getting blood and other body fluids on their faces. Another inconsistent study done in Saudi Arabia found that 19.3% of HCWs always wore goggles while doing procedures.[20] Regarding gowns, 56.5% of nurses always wore a gown when caring for a patient who posed a risk of blood and other body fluids splashing on their clothes. This result is in the same line with one from a study, which discovered that 49.7% of Brazilian nurses wore a gown or apron when they were around body excretions.[16] Most nurses wore masks when they cared for a patient who sneezed or coughed (80%). On the contrary, this result is inconsistent with that of a study that revealed that only 20.2% of HCWs were wearing face masks.[23] Another finding indicates a lower percentage, reporting that 54.8% of HCWs often wore face masks when necessary.[24] As to injection safety and sharp injuries, only 6.8% of nurses never recapped the used needle before disposal, 31.8% never bent needles before disposal, and 84.3% always disposed of the used needle and blades in the special sharp utensils container. However, only 10.3% never closed the sharps container and replaced it when it was half full. Similarities can be found with a cross-sectional study conducted in Brazil and Hong Kong; 33% of Brazilian nurses never recapped the used needle, 93.8% of Hong Kong nurses put used sharps into a sharps container, and 16% of Brazilian nurses disposed of the sharps container when it was full.[16] Most nurses always wore gloves when disposing of needles and other infectious materials (66%), and the highest percentage of them wore gloves when they performed injections or took blood for patients (73.5%). This result is consistent with that of a cross-sectional study, indicating that 73.4% of HCWs wore gloves when performing injections on patients.[17]

Figure 1 shows that the highest percentage (51.5%) of nurses have a poor practice score, while the lowest percentage (48.5%) of them have a good practice score. This result is similar to that of a study carried out in Cyprus, which reported that 69.1% of HCWs had unsatisfactory practice of SPs, while only 30.9% of them had satisfactory practice.[17] This study is in the same line with another study which revealed that 53.3% of participants had poor practice in infection prevention SPs.[19] Another study conducted in Iran showed that 42% of nurses had average practice.[25] In Iraq, a study revealed that 66.67% of nurses had a good level of practice in infection prevention.[21]

Conclusion and Recommendation

According to the results, most nurses have a poor level of practice for standard precautions; we recommend that educational courses and training workshops should be held for nurses to improve their practice of these measures. Also, there is a need to enhance behavioral modifications to reduce exposure to nosocomial infections and acute injuries (e.g., not recapping or bending needles after use). Developing a program for tracking HAIs in different wards according to standard protocols, introducing monthly reporting, and rewarding wards with the lowest HAI cases may all contribute to improving the practice of standard precaution measures.

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ORIGINAL ARTICLE

Iranian Dietitians' Viewpoints on Virtual Nutritional Consultation on the Instagram Platform: A Descriptive, Cross-sectional Study

Mojtaba Khadem Al-Hoseini[1], MSc; Mostafa Lofti[2], MSc; Farzaneh Mohammadi[3,4], PhD; Gordon A Ferns[5], MD; Marzieh Akbarzadeh[6], PhD

[1]Department of Nutrition, School of Public Health, Iran University of Medical Sciences, Tehran, Iran
[2]Student Research Committee, School of Nutrition and Food Sciences, Shiraz University of Medical Sciences, Shiraz, Iran
[3]Nutrition Research Center, Department of Clinical Nutrition, School of Nutrition and Food Sciences, Shiraz University of Medical Sciences, Shiraz, Iran
[4]Student Research Committee, School of Nutrition and Food Sciences, Shiraz University of Medical Sciences, Shiraz, Iran
[5]Department of Medical Education, Brighton and Sussex Medical School, Brighton, BN2 9PH, UK
[6]Nutrition Research Center, Department of Community Nutrition, School of Nutrition and Food Sciences, Shiraz University of Medical Sciences, Shiraz, Iran

Correspondence:
Farzaneh Mohammadi, PhD; Nutrition Research Center, Department of Clinical Nutrition, School of Nutrition and Food Sciences, Shiraz University of Medical Sciences, Shiraz, Iran
Tel: +98 9171043924
Email: mohamadyfa@sums.ac.ir
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Abstract

Background: Today, the use of social media for health care advice has become more popular. The present study aimed to evaluate the opinions of Iranian dietitians on virtual nutritional counseling on the Instagram platform.

Methods: The present descriptive, cross-sectional study enrolled Iranian dietitians working in the field of nutrition counseling using Instagram. The link to an online questionnaire including questions on their activity in virtual counseling on Instagram and the challenges of virtual counseling was sent to the 131 participants. Descriptive statistics were used to analyze and interpret the data.

Results: Out of 163 dietitians, 131 participated in the study. 47.3% started virtual counseling during COVID-19, and 35.2% had more virtual clients. 58.8% preferred face-to-face counseling for concept transfer, and 43.5% found it more effective. Text and voice messaging were the most practical methods for virtual counseling, with weight loss being the most common topic.

Conclusion: During the COVID-19 pandemic, virtual nutritional counseling became more widespread. However, it is believed that face-to-face counseling is more effective in conveying concepts. For virtual platforms, text messaging is the most practical method for nutrition counseling, followed by voice messaging. It has been observed that the elderly have been the least likely people to seek virtual nutrition counseling, while weight loss counseling has been the most frequently requested topic.

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Keywords: Nutrition consulting, Coronavirus disease 2019 (COVID-19), Social media, Nutritionist, Dietitian

Introduction

Using social media to deliver health-related information and provide counseling has been developed with the popular use of social media. However, it was not widely used before the pandemic, due to the limitations such as lack of advanced communication technologies.[1] Today, with the advancements of science and technology in the field of communication software and virtual platforms, many of the previous limitations no longer exist. Within the outbreak of the COVID-19, measures such as the implementation of social distancing policies and guidelines related to staying at home were taken to prevent the outbreak of this disease in all countries.[2] These restrictions have affected the provision of health care in health centers.[1,2] To overcome this limited access to health-related services, healthcare centers developed strategies to continue their services while ensuring the safety of staff and clients.[3] Meanwhile, the activity of nutrition consultants also faced challenges in providing nutrition counseling services to clients.[4] In this situation, turning to virtual counseling, as an alternative method to

the traditional face-to-face consulting method, seemed inevitable. Even after the lockdowns, telemedicine and virtual nutrition counseling were shown to improve the clients' access to healthcare, and also save money and time.[5]

Through the expansion of health-oriented activities in the virtual space, a large amount of non-scientific information related to food, vitamins, or certain plants has been disseminated by social media, which can affect social health.[6] This issue demonstrates the importance of the presence of dietitians in virtual space and the provision of reliable and evidence-based nutritional information, especially during the COVID-19 pandemic.[4]

According to the studies, Instagram social medium is one of the most popular platforms for businesses in Iran,[7, 8] and pieces of evidence show that virtual nutrition counseling on virtual platforms has increased,[9] but there remains little information on the dimensions, effectiveness, and challenges of these virtual activities. To address this information gap, the present study was designed to evaluate the opinions of Iranian dietitians on virtual nutritional counseling on the Instagram platform.

Methods

This descriptive, cross-sectional study was approved by the Research Ethics Committee of Shiraz University of Medical Sciences (IR.SUMS.SCHEANUT.REC.1402.115). As there was no statistical data from nutritionists on Instagram to establish the sample size, the census sampling method was utilized. Participants were informed of the purpose and data collection process of the study; in case they were willing, they were included in the study.

The study population included active nutrition consultants on Instagram. A thorough search on Instagram using keywords such as "nutritionist", "master nutritionist", "PhD in nutrition", "diet therapist", "nutrition consultant", "diet", "nutrition and diet therapy", and "diet therapy" was conducted. From the 163 identified Instagram pages, an online questionnaire link was sent to all eligible nutrition consultants. Out of these, 9 pages were managed by the admin some consultants were unwilling to cooperate, and 23 of them did not have enough time or willingness to complete the questionnaire or did not answer all the questions. Finally, 131 participants completed the questionnaire voluntarily (Figure 1).

The inclusion criteria included having a degree in nutrition science, having a medical council number or being a member of a legal association in the field of nutrition, and having an active page on Instagram for nutrition counseling. The aim and methods of the study were explained to the participants. In case of acceptance to participate, a link to an online questionnaire was sent to them. The questions were designed based on the researcher's experience and input from nutrition experts on Instagram.

The data collection tool was an online questionnaire consisting of 29 questions in four sections. The first part included demographic questions such as age, gender, level of education, and place of residence. The second part contained questions related to the activity of nutrition consultants, the objectives of the activities of consultants on the Instagram platform, impact of COVID-19 on the activities of consultants, and amount of their use of different virtual platforms.

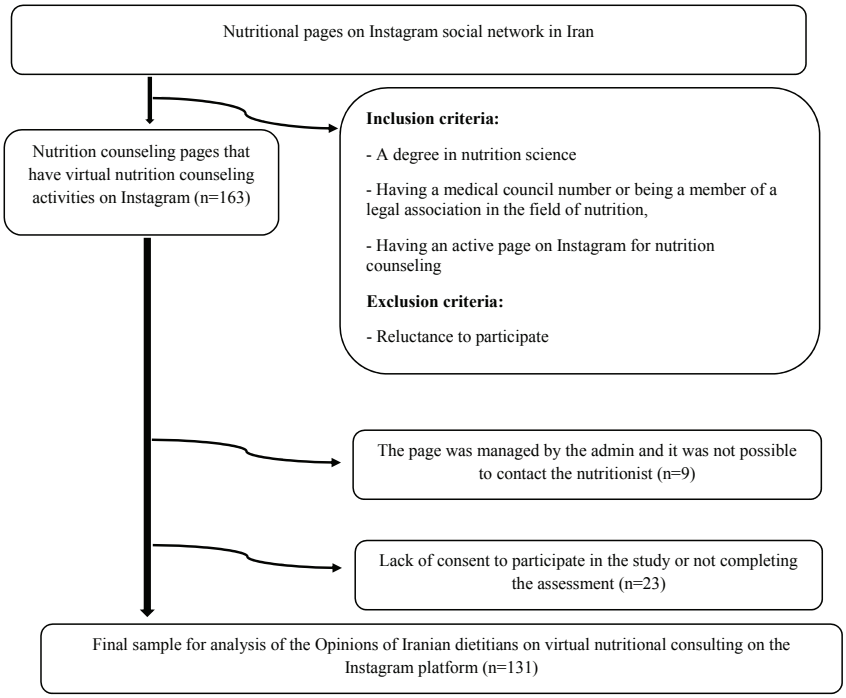

Figure 1: Flow diagram of the study

In the third part, there were questions about the methods used for counseling on Instagram, methods of advertisement in virtual space, information on their virtual clients such as age groups and the like, and most topics of nutrition counseling. The last part of the questions was about the methods and references used to produce scientific content for their pages. The online questionnaire was made available using the Porsline platform (www.porsline.com).

Data were analyzed and interpreted using Statistical Package for Social Sciences (SPSS) software (version 22.0, SPSS Inc., Chicago, IL, USA). Qualitative variables were reported as numbers and percentages and quantitative variables as mean and standard deviation. Due to the descriptive design of the study, analytical tests were not used.

Results

Out of 163 active dietitians on the Instagram platform for nutrition counseling, 131 volunteers completed the questionnaire. The mean age of the participants was 30.8±6.7 years, and women constituted 87.8% of them. Most participants had a bachelor's degree (47.3%) in nutrition sciences. More than half of them (55%) had been engaged in virtual counseling for 6-24 months. Most of these nutrition consultants (84%) had less than 5000 followers on their Instagram pages, and more than half of their followers (58.8%) were from the province where the consultant resided. Most of the followers of nutrition consultants' Instagram pages were from Tehran, Fars, and Khorasan Razavi provinces based on priority. Also, 32.1% of the consultants had a history of providing nutritional counseling to foreign users (Table 1).

Approximately, one-third of the participants who had consulted in virtual media reported this way as their sole source of income, and 37.4% stated that their leading purpose of virtual consulting was to be recognized to have more clients for their offices. Some participants (29.8%) also expressed that providing a complete and comprehensive service portfolio for their clients caused them to be active on Instagram. Of the participants, 30.5% were only engaged in nutrition counseling on Instagram, but 42.7% were working in clinics or their offices as well, 9.9% in health centers and 8.4% in hospitals.

Out of all the consultants, 47.3% had started their consulting activities in virtual space during the COVID-19 pandemic, and 35.2% of them believed that since the beginning of this pandemic, their virtual clients had increased. Almost 35% of the participants used social media other than Instagram, such as WhatsApp, Telegram, etc., and 11.5% were also active in medical consulting applications besides Instagram.

The Methods of Nutritional Counseling in Virtual Space

The methods of nutrition counseling in virtual space were reported by the participants based on priority to four methods: text message, voice message, phone call (or internet call), and video call. According to the findings, 66.4% of the participants used text and voice messaging for nutrition counseling for their clients. The use of the telephone (or internet calls) and video calls was reported 16.8% and 7.6%, respectively. Even though 67.9% reported voice messages and 44.3% of text messages as effective methods for counseling, after these two, the use of video calls was 30.5%, and the use of phone or Internet calls accounted for the lowest percentage.

The Method of Advertisement in Virtual Space

The extensive methods used by dietitians to

Table 1: Characteristics of the study participants

Variable		N=131	
		n	%
Gender	Female	115	87.8
	Male	16	12.2
Education level	BSc student	3	2.3
	Bachelor	62	47.3
	MSc student	23	17.6
	Master	32	26.7
	PhD student	5	3.8
	PhD	3	2.3
Duration of activity of nutritionists on Instagram	Less than 6 months	30	22.9
	6 months–1 year	36	27.5
	1–2 years	36	27.5
	2–4 years	18	13.7
	More than 4 years	11	8.4
The number of followers on Instagram	Less than 2000	79	60.3
	2000-5000	31	23.7
	5000-10000	13	9.9
	10000-20000	3	2.3
	More than 20000	5	3.8

introduce themselves on Instagram included being introduced by clients to others (74%), advertising on other pages (41.2%), and being introduced or followed by the pages of other colleagues active in the field of nutrition counseling (7%) (Table 2).

Comparison of the Results of Virtual Counseling Versus Face-to-Face Counseling

More than half (58.8%) of nutrition counselors believed that transferring concepts to clients was better in face-to-face counseling compared to virtual counseling. Meanwhile, 32.1% of the counselors also believed that there was no difference between virtual and face-to-face methods for conveying concepts to clients. As to achieving the desired results following nutrition counseling, 49.6% of the counselors pointed out no difference between face-to-face and virtual methods. Nevertheless, 43.5% of the participants stated that face-to-face clients achieved better results than virtual clients, and only 6.9% of them believed that the feedback from virtual consulting was better than the results of face-to-face consulting.

Although most dietitians (59.5%) did not express any difference between the nutritional and health information of virtual space users and in-person clients, 20.6% of the consultants considered the information of virtual space users to be higher.

Given the gender differences in face-to-face counseling versus virtual counseling, 52.7% of the counselors did not have an opinion on this matter, but 42% of them stated that the majority of applicants for virtual counseling were women.

Fields of Nutrition Counseling on Virtual Media

According to the report of nutrition consultants, the largest age group that received virtual nutrition counseling was young people, and the smallest age group was the elderly. Besides, the most to least frequently consulted topics were weight loss, weight gain, and nutritional counseling for various diseases, respectively (Table 3). Based on the participants' experiences, content related to "weight loss" was more favorable to Instagram users than other topics. Topics such as "the caloric content of different foods", "healthy cooking for dieters", and "weight gain" were placed in the following priorities.

The Content of Nutritional Pages on Instagram

Many participants (70.2%) believed that the amount of unreliable content and pages on nutrition and diet therapy was very high on Instagram. Also, a significant number of nutrition consultants (45.8%) claimed that much of the content produced by them were copied on other pages without permission.

The amount of time that the dietitians spent preparing posts and stories on Instagram was 62.6% for less than 2 hours, 26% for approximately 2 to 4 hours, 8.4% for between 4 and 6 hours, and 1.3% for more than 6 hours a day. More than 75% of the content and design of page posts and stories in 61.4% of consultants were entirely prepared by their own. Nonetheless, in only 1.5% of the pages, less than 25% of the content and design of the posts and stories belonged to them.

The priority of most dietitians (64.1%) for creating content for their pages on Instagram was textbooks. Other authentic books, articles, and other authentic pages on Instagram are shown in Table 4.

Discussion

The application of online counseling in the field of health and nutrition has rapidly developed in recent years, especially during the COVID-19 pandemic.[3-5] However, in the current situation, the status of nutritional

Table 2: The method of advertisement in virtual space

Methods	N=131	
	n	%
Advertising on other pages	43	32.8
Being introduced or followed by the pages of other active nutritionists	36	27.5
Introducing or being followed by the pages of other fields of medical sciences	31	23.7
Using the presence of celebrities on page	19	14.5
Introducing to other people by users	88	67.2
Other	13	9.9

Table 3: The content of nutritional pages on Instagram

Topics	First priority		Second priority		Third priority	
	n	%	n	%	n	%
Weight loss	91	69.5	4	3.1	0	0
Gain weight	3	2.3	63	48.1	14	10.4
Diseases	1	0.8	26	19.8	60	45.8
Pregnancy	1	0.8	2	1.5	12	9.2
Lactation	0	0	1	0.8	9	6.9
No opinion	35	26.7	34	26	34	26

Table 4: References used for content production for pages

References	First priority		Second priority		Third priority		Forth priority		Fifth priority		Sixth priority	
	n	%	n	%	n	%	n	%	n	%	n	%
Textbooks	84	64.1	25	19.1	8	6.1	9	6.9	5	3.8	0	0
Other books	2	1.5	44	33.6	27	20.6	10	7.6	24	18.3	22	16.8
Authentic articles	30	22.9	37	28.2	46	35.1	10	7.6	3	2.3	4	3.1
Own knowledge	9	6.9	12	9.2	24	18.3	66	55.4	12	9.2	7	5.3
Own experience	0	0	8	6.1	16	12.2	30	22.9	64	48.9	12	9.2
Authentic pages	6	4.6	4	3.1	10	7.6	6	4.6	19	14.5	79	60.3
Other	0	0	1	0.8	0	0	0	0	4	3.1	7	5.3

counseling services in virtual space is not clearly studied. In the current study, the opinions of Iranian dietitians on virtual nutritional counseling on the Instagram platform were evaluated. Results of the present study revealed that half of the nutrition consultants started virtual nutrition counseling activities during the COVID-19 pandemic, and more than one-third of dietitians believed that the number of their virtual clients had increased compared to before the pandemic. Though more than half of the nutrition counselors considered the transfer of concepts in face-to-face nutrition counseling to be better than virtual counseling, a significant percentage of counselors stated that the results in face-to-face clients led to better results. According to the participants, the most practical method for nutrition counseling on virtual platforms was using text and voice messages, and the most common topic of virtual nutrition counseling was related to weight loss.

During the COVID-19 pandemic, virtual nutrition counseling was developed in all countries. In a descriptive study conducted in the United States of America (USA) on 22 dietitians in 2021, an increase in non-attendance nutrition counseling during COVID-19 was reported.[6] Also, another cross-sectional study using an online 54-question questionnaire on 2198 nutrition consultants in the USA indicated that the activity of non-attendance nutrition counseling during COVID had increased.[10] Based on the results of the present study, half of the dietitians began their consulting activities during the COVID-19 pandemic, and more than one-third of them considered that the number of their virtual clients had augmented compared to before COVID-19. Due to the restrictions caused by the COVID-19 pandemic and healthcare professionals turning to alternative methods to access services, virtual counseling has been expanded and promoted in recent years.[9, 11] Besides, clients welcome virtual nutrition counseling to reduce problems such as distance, in-person referral costs, and easier access.[12] However, the problems and limitations of providing telemedicine services, including the lack of public access to the infrastructure required for virtual services, protecting people's privacy, problems related to financial payments, and issues related to supervision must be considered in this field.[13]

In this study, more than half of the participants believed that face-to-face counseling worked better in conveying the concepts to clients, while one-third of them believed there was no difference between face-to-face and virtual methods. Even though a significant percentage of consultants stated that face-to-face clients achieved better results, only a few of them considered the outcomes of virtual clients to be better. There are few published studies in this regard, and their results are quite conflicting. Another study reported that dietitians could provide high-quality and effective services through virtual consultations, particularly the results that are comparable to the outcomes of face-to-face consultations.[14] Also, some researchers descriptively studied 200 dietitians in the USA and reported that due to the limitations of virtual nutrition counseling, such as the impossibility of anthropometric and malnutrition assessment, face-to-face nutrition counseling is more effective for initial nutritional screening and assessment. However, virtual counseling may be more appropriate for ongoing patient monitoring and evaluation.[6] The use of virtual platforms has potential advantages because it makes access to counseling and health care feasible, especially in epidemics; reduces the costs; and overcomes geographical distances.[15, 16] On the other hand, the dietitian can visualize the cooking style, the dishes used, and the amount and type of food served.[17] Despite all these advantages, the impossibility of measuring anthropometric factors and relying on subjective reports of weight, size, and some eating habits by clients were among the limitations of the virtual consultation method.[18] Otherwise, in face-to-face counseling, there is more motivation to continue the treatment process and positive behavioral changes for the clients. Besides, it seems that the physical presence of the therapist in face-to-face communication makes the client more compliant even for some time after the face-to-face session.[19] Considering that the results of nutrition counseling are highly dependent on positive behavioral changes in the client, the reason for better results in face-to-face

clients can be these better behavioral changes, more motivation, and more continuity of the treatment process in face-to-face counseling. However, to improve the success of virtual counseling, some solutions have been suggested for nutrition counselors, including minimizing environmental noises, speaking frankly and clearly, pausing while speaking to create an opportunity to ask questions by the client, answering their questions, placing the camera facing the consultant's face, and wearing official outfits in the use of video calls.[15] In addition, special attention should be paid to privacy when transmitting the patient information in a virtual method.[12]

Although the prevalence of overweight, obesity, and chronic diseases in the elderly is higher than in other ages,[20] they received virtual counseling less frequently than other age groups in the present study. Though no study has been conducted in Iran to investigate the level of access and use of virtual platforms in different age groups, it is predictable that the level of access and use of virtual platforms among the elderly is less than in other age groups. A cross-sectional study reported that limitations such as low education level and low income level, physical and mental disorders, and the lack of modern technology during the life of the elderly caused a more limited use of the Internet and virtual platforms compared to other age groups.[21] Also, another study reported that due to socio-economic factors, education, and income, the elderly have less access to the virtual space and use the Internet less frequently.[22] This limited access and less familiarity with virtual platforms among the elderly can be one of the shortcomings of virtual nutrition counseling using virtual media.

Based on the results of the present study, nutrition counselors have reported that the most practical and standard method of counseling and communication with clients is text messaging followed by voice messages. Also, based on the results of a review study, text messaging was introduced as an accessible, practical, and inexpensive method to change health-related behaviors.[23] Another review study mentioned text messaging as a quick, popular, and cheap method in virtual counseling for health-related issues.[24] Since text messaging is more accessible than other communication methods, such as video calls, voice messages, etc., and has fewer time and place restrictions, this method can be more acceptable and popular among clients in virtual consultations through virtual platforms.

According to the results of our study, the most common topic of virtual nutrition counseling was "weight loss." A cross-sectional study, conducted in Australia, stated that overweight and obesity are the most common reasons for referrals to dietitians.[25] This result is not far from expectations because the prevalence of overweight and obesity among adults is increasing, and it has been estimated to be 59.3% in Iran.[20] Health-related issues of obesity and also issues related to beauty and fitness can be a reason for more concern about this problem and, as a result, increase referrals to dietitians for weight control.

One of the main strengths of this study was that it examined the virtual counseling activities of Iranian dietitians on a popular medium among Iranians and also compared it to face-to-face counseling. However, it had several limitations. First, in the present study, only the Instagram platform was considered, and other social media platforms were not evaluated, which might have led to missing some data. Second, it can be pointed out the fact that the study participants were inclined toward virtual counseling, and their opinions on the comparison between face-to-face and virtual counseling must be interpreted cautiously. Third, the participants of the study just reported their experiences regarding virtual nutritional counseling and its effectiveness and the like.

Conclusion

The findings indicated that the virtual activity of dietitians has expanded during the COVID-19 pandemic, which can improve fairer access to nutrition counseling services and reduce the cost and travel time for clients. Of course, based on the results of the present study, the transfer of concepts and results obtained from nutritional counseling in face-to-face counseling will be more effective than in virtual counseling. According to the participants, the most practical method for nutrition counseling on virtual platforms is text messaging followed by voice messaging. Among the age groups, the elderly have taken the minimum action to receive virtual nutrition counseling, and weight loss counseling has been the most requested topic in virtual nutrition counseling. At last, to reach an evidence-based robust conclusion in this area, future prospective studies are required to compare the effectiveness of face-to-face and virtual nutrition counseling.

Authors' Contribution

ML and MK conceived and designed the study. MA and GAF analyzed and interpreted the data. FM prepared the English manuscript. All the authors approved and revised the manuscript.

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