JOURNAL OF REHABILITATION SCIENCES AND RESEARCH

The Official Quarterly Publication of Shiraz University of Medical Sciences (SUMS)

Published by:
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:
Office of Journal of Rehabilitation Sciences and Research, School of Rehabilitation Sciences, Abiverdi 1 Street, Chamran Boulevard, Shiraz, Iran.
P.O.Box: 7194633669
Tel: ±98 71 36271551
Fax: ±987 1 36272495
Email: journal.of.rsr@gmail.com
Web: http://jrsr.sums.ac.ir

EDITORIAL BOARD

Instructions to Authors

The JRSR Aims and Scope

The Journal of Rehabilitation Sciences and Research (JRSR) is a quarterly and an editorially independent publication owned by Shiraz School of Rehabilitation Sciences and aims to be a publication of international repute for reporting current regional and international adventures in all aspects of rehabilitation sciences. JRSR welcomes contributions in this field in the form of original research articles, case reports, letter to the editor, and review articles. The Journal seeks to provide its readers with the highest quality scientific information published through a process of careful peer reviews and editorial comments. All publications are in English.

The following guidelines refer to the JRSR requirements for receiving your manuscripts for possible publication. Relying on this guideline speeds up the process of evaluation and publication of the submitted paper. We, regretfully, declare the rejection of those contributions that deviate from the Journal Guidelines.

1. Requirements for Submission of Manuscripts

The manuscript should be prepared exclusively in Microsoft Word format (2007) with no more than 3000 words, excluding Title, Authors (names and affiliations), and References using Times New Romans font.

1.1. Title Page

The title page for both original research and case reports should include:

1) The title of the paper, which should be concise but informative. This title should be written with normal writing style and only the initial of the specific names should be capitalized.

2) The name of each author with his or her highest academic level(s) and institutional affiliation. This also should be written with normal style including the first name followed by surname(s).

1.2. Abstract and Keywords

The submission should carry an abstract of no more than 300 words for structured abstract in original research articles. This abstract should state:

1. Background and objective(s) (originality and purpose(s) of the study or investigation)

2. Method(s) (selection of study subjects or laboratory animals; observational and analytical methods)

3. Results (giving specific data and their statistical significance, if possible)

4. Conclusion (emphasizing new and important aspects of the study or observations).

The unstructured abstract for a case report should state a summary of the case report with no specific headline but including the main corpus knowledge of the report not exceeding 150 words.

For review articles an unstructured abstract maximum to 300 words is eligible.

Letters to the editor carry not any abstract

Below the abstract authors should provide, and identify as such, 3 to 5 keywords or short terms selected from the Medical Subject Headings (MeSH).

1.3. The Headlines of Original Research Text body

Introduction

State the purpose of the article and summarize the rationale for the study or observation. Give only strictly pertinent references and do not include data or conclusions from the work being reported.

Methods

Describe your selection of the observational or experimental subjects (patients or laboratory animals, including controls) clearly. Identify the age, sex, and other important characteristics of the subjects.

Identify the methods, apparatus (give the manufacturer's name and address in parentheses), and procedures in sufficient detail to allow other workers to reproduce the results. Give references to established methods, including statistical methods; provide references and brief descriptions for methods that have been published but are not well known; describe new or substantially modified methods, give reasons for using them, and evaluate their limitations. Identify precisely all drugs and chemicals used, including generic name(s), dose(s), and route(s) of administration.

Reports of randomized clinical trials should present information on all major study elements, including the protocol (study population, interventions or exposures, outcomes, and the rationale for statistical analysis), assignment of interventions (methods of randomization, concealment of allocation to treatment groups), and the method of masking (blinding).

Results

Present your results or findings in logical

sequence in the text, tables, and illustrations. Do not repeat in the text all the data in the tables or illustrations; emphasize or summarize only important observations.

Discussion

The behavior of models or specimens should be discussed. It is useful to begin the discussion by summarizing briefly the main findings, then explore possible mechanisms or explanations for these findings, compare and contrast the results with other relevant studies, state the limitations of the study, and explore the implications of the findings for future research and for clinical practice.

Conclusion

Emphasize the new and important aspects of the study and the conclusions that follow from them. Link the conclusions with the goals of the study but avoid unqualified statements and conclusions not completely supported by the data. In particular, authors should avoid making statements on economic benefits and costs unless their manuscript includes economic data and analyses. Avoid claiming priority and alluding to work that has not been completed. State new hypotheses when warranted, but clearly label them as such. Recommendations, when appropriate, may be included.

1.4. The Headlines of Case Report Text body

Introduction

Give a very short identification of the specific disease or abnormality you are going to investigate and its originality. If the disease treatment needs a background to be clear for readers include previous treatment(s) as well.

Case report

This section includes all informative details about the case and the way he/she has been selected for treatment or report. The case history and prescribe should be included.

Discussion

You should include your findings in this section in a detailed form so that successors could follow reported treatment or operation.

1.5. The Headings of "Review Article" and "Letter to the Editor" Text body

Review articles' headings are including: background, review of literature, discussion, and conclusion.

Submissions of review articles are only expected from experts in the fields.

"Letter to the editor" contribution to JRSR should be totally 1-2 pages involving announcement of innovations, establishments, achievements, and continuation or discontinuation of a method/ procedure in the Journal fields. The Letter begins with a suitable concise title and then furthers with an introductory paragraph on the issue's background or author's intention to such contribution.

1.6. Acknowledgments

Acknowledgments should specify 1) contributions that need acknowledging but do not justify authorship, such as general support by a departmental chair; 2) acknowledgments of technical help; 3) acknowledgments of financial and material support, which should specify the nature of the support; and 4) relationships that may pose a conflict of interest.

Acknowledgements are mentioned in a sole paragraph maximum to 30 words. Conflict of interest and financial issues (if any) must be inserted after acknowledgement paragraph.

1.7. Citations and References

References should be numbered consecutively in the order in which they are first mentioned in the text. Identify references in text, tables, and legends by Arabic numerals in square parentheses. The references must follow the Vancouver style and should not exceed 30 references (40 for Review articles). A number in square brackets is allocated to a source in the order in which it is cited in the text.

1.8. Tables and Illustrations (Figures)

Type, insert or print out each table with double spacing on appropriate place in the article. Do not submit tables as photographs. Number tables consecutively in the order of their first citation in the text and supply a brief caption for each.

2. Sending the Manuscript to the Journal

2.1. Submission

Authors are encouraged to submit their manuscript electronically to the Journal Website (http://jsrs.sums.ac.ir), and send a full copy of their manuscript with required formats (described in previous sections) to JRSR email (jrsr@sums.ac.ir).

2.2. Conflict of Interest, Financial and Ethical Issues

Manuscripts must be accompanied by a covering letter signed by all coauthors. This must include 1) information on prior or duplicate publication or submission elsewhere of any part of the work as defined earlier in this document; 2) a statement of financial or other relationships that might lead to a conflict of interest 3) a statement that the manuscript

has been read and approved by all the authors, that the requirements for authorship as stated earlier in this document have been met, and that each author believes that the manuscript represents honest work; and 4) the name, address, and telephone number of author(s), and specifying an author as corresponding person for communicating with the other authors about revisions and final approval of the proofs.

3. Quality Control and peer-Reviewing Process

Each submission to JRSR passes through a rigorous quality control and peer-review evaluation process before receiving a decision.

For a most targeted peer-reviewing process, authors are encouraged to enclose in their Cover Letter at least three in-field researchers/physicians, but the JRSR is not obliged to use that suggestions

4. Randomized controlled trials

All randomized controlled trials submitted for publication in JRSR should include a completed Consolidated Standards of Reporting Trials (CONSORT) flow chart. Please refer to the CONSORT statement website at http://www.consort-statement.org for more information. The Journal has adopted the proposal from the International Committee of Medical Journal Editors (ICMJE) which require, as a condition of consideration for publication of clinical trials, registration in a public trials registry. Trials must register at or before the onset of patient enrolment. The clinical trial registration number should be included at the end of the abstract of the article.

Address

Office of Journal of Rehabilitation Sciences and Research,
School of Rehabilitation Sciences,
Abiverdi 1 Street, Chamran Boulevard,
Shiraz, Iran.
P.O.Box: 7194633669
Tel: ±98 71 36271551
Fax: ±987 1 36272495
Email: journal.of.rsr@gmail.com
Web: http://jrsr.sums.ac.ir

JRSR

Journal of Rehabilitation Sciences and Research

Vol. 11, No. 2, June 2024

Journal of Rehabilitation Sciences and Research

Journal Home Page: jrsr.sums.ac.ir

Review Article

Impact of the FIFA 11+ Warm-up Program on Injury Prevention in Soccer Players and Other Sports: A Systematic Review

Reza Sharifatpour[1], PhD; Hamid Abbasi[1], PhD; Saeed Abedinzadeh[1*], PhD

[1]Department of Sport Sciences, Yazd University, Yazd, Iran

ARTICLE INFO

Article History:
Received: 29/05/2022
Revised: 27/05/2023
Accepted: 04/07/2023

Keywords:
FIFA 11+
Warm up program
Injuries
Soccer
Handball

Please cite this article as:
Sharifatpour R, Abbasi H, Abedinzadeh S. Impact of the FIFA 11+ Warm-up Program on Injury Prevention in Soccer Players and Other Sports: A Systematic Review. JRSR. 2024;11(2):61-69. doi: 10.30476/JRSR.2023.95670.1295.

ABSTRACT

Background: This study systematically reviewed scientific literature regarding the effects of the FIFA 11+ warm up program on preventing injuries in soccer and other sports.
Methods: We performed a systematic review and conducted a keyword search on 10/09/2022, in PubMed, Google Scholar, CINHAL, Web of Knowledge, Cochrane, Scopus in English language, also in Magiran, SID, Google Scholar, and Noormags in Persian language were reviewed.
Results: The results of the study were from 1192 English papers and 143 Persian papers, finally 73 eligible studies were selected and a total of 18378 players were studied. The quality level of the studies was at Level II, Twenty studies, which were at least Level II. Analysis of studies shows that the FIFA 11+ warm-up program for the prevention of sports injuries had positive effects and improve the performance of soccer players.
Conclusion: One type of training for an amateur or professional group will not have the same effect and the intensity and duration of the program should be optimized. It is also necessary for the other sports to become more specialized in preventing injury programs.

Introduction

Soccer stands out as one of the most beloved sports worldwide, yet it also carries a significant risk of injury. Previous studies have underscored the heightened prevalence and risk of injuries within soccer [1]. Research indicates that the incidence of injuries in soccer surpasses that of other field sports [1].

Among male soccer players, the prevalence of sports injuries is estimated to range from 10 to 35 injuries per 1,000 hours of match play, translating to an occurrence of injuries in elite soccer players at least once per year [2]. Remarkably, between 65% and 95% of these injuries manifest in the lower extremities [1, 3], emphasizing the imperative to address these specific injuries to enhance the safety and well-being of soccer players. Implementing preventive programs becomes paramount to mitigating injuries and alleviating their substantial costs. Fundamental to these programs is thoroughly comprehending the mechanisms and causes of injuries [4].

Numerous studies have been conducted in the realm of soccer injury prevention, employing a variety of training methods and exercises. Warm-up programs have emerged as one of the most common preventive measures across various sports, including soccer [5].

A pivotal milestone in this area was marked by Ekstrand et al.'s pioneering study three decades ago [6, 7]. This study, conducted by Ekstrand and Gilkovist in 1983, implemented a comprehensive program for Swedish professional male soccer players, encompassing various preventive measures such as specialized exercises, modified training routines, and equipment adjustments. The findings of this study revealed a remarkable 75% decrease in injuries among the players. However, the multifaceted nature of the interventions employed in this

*Corresponding author: Saeed Abedinzadeh, Department of Sport Sciences, Yazd University, Yazd, Iran
Email: sabedin@yazd.ac.ir

program made it challenging to discern and isolate the effects of each intervention.

Following Ekstrand et al.'s seminal work, there was a notable gap in cohesive studies on soccer injury prevention until 2002. However, the field has grown significantly in such endeavors over the past decade. In 2002, Jang et al. designed the first comprehensive prevention program tailored for young male athletes aged 14 to 19, spanning various skill levels. Their findings indicated a noteworthy 36% reduction in injuries among participants in the training group [8].

The FIFA (Fédération internationale de football association) Research and Evaluation Group introduced a program (Warm-up for the Prevention of Injury) titled "11" in 2004, drawing inspiration from Jang et al.'s study. This initiative aimed to enhance core muscle strength, improve neuromuscular control, and augment soccer players' agility and explosive power. Subsequently, Stefan et al. investigated the efficacy of this preventive program among young female athletes aged 14 to 18. Their findings revealed no significant difference in overall injury incidence between the intervention and control groups, primarily attributed to varying degrees of adherence among coaches, trainers, and players in implementing the program [9].

Following numerous studies on injury prevention, FIFA's Center for Research and Evaluation recognized the need to address shortcomings in the FIFA Warm Up Program "11+," notably its lack of diversity and progressive training components. To remedy these deficiencies, FIFA collaborated with the Oslo Sports Trauma Research Center and the Santamunica Sports and Orthopedic Center to develop the widely renowned "11+" warm-up training program for preventing lower extremity injuries in soccer players.

Numerous studies have investigated the efficacy of the FIFA 11+ warm-up program, with findings consistently documenting its effectiveness in reducing lower extremity injuries [5, 10]. Furthermore, there is growing interest in exploring the applicability of preventive exercises, such as the FIFA 11+ warm-up program, in other sports disciplines [11].

While originally designed for soccer, the FIFA 11+ warm-up program has effectively reduced injuries across various sports disciplines. Notably, research has investigated its impact on basketball, revealing its efficacy in preventing injuries among Italian basketball players in a randomized controlled trial (RCT) [12]. Although fewer studies have been conducted on injury prevention in handball, those that have explored various warm-up protocols have consistently reported positive outcomes regarding injury reduction [13-15]. For instance, a recent study by Abedinzadeh et al. found that a modified FIFA 11+ warm-up program positively affected injury reduction among elite handball players [16]. Given these findings, this study aims to provide an overview of research progress concerning the effects of the FIFA 11+ warm-up program on injury prevention, both in soccer and other sports contexts.

Methods

This systematic review study aimed to examine published research articles in both English and Persian languages, focusing on the effectiveness of the FIFA 11+ warm-up program in preventing soccer injuries. The search, conducted as of 10/09/2022, yielded 1192 English articles and 143 Persian articles across various scientific databases. Specifically, 34 articles were identified in PubMed, while 1158 were found through databases such as Google Scholar, Web of Knowledge, Scopus, Cochrane, and CINHAL. Additionally, seven articles were retrieved from Magiran, three from SID, 128 from Google Scholar, and five from Noormags, all in Persian. The inclusion criteria for articles encompassed studies that investigated exercises incorporated within the FIFA 11+ warm-up program, as well as articles evaluating the overall impact of this program on injury prevention in soccer.

The search strategy employed a combination of English and Persian keywords. For English databases, the search utilized the following keywords: (football OR soccer OR handball OR basketball OR futsal) AND (fifa-11 OR fifa-11 + OR fifa-11-plus) AND injury.

((“football” [MeSH Terms] OR “football” [All Fields]) OR (“soccer” [MeSH Terms] OR “soccer” [All Fields]) OR handball [All Fields] OR (“basketball” [MeSH Terms] OR “basketball” [All Fields]) OR futsal [All Fields]) AND (fifa-11[All Fields] OR fifa-11+ [All Fields]) AND (“wounds and injuries” [MeSH Terms] OR (“wounds”[All Fields] AND “injuries” [All Fields]) OR “wounds and injuries” [All Fields] OR “injury” [All Fields])

For Persian databases, the search terms included variations of “FIFA 11,” “prevention,” and “injury” in the Farsi language.

Results

After identifying 901 articles, the titles and abstracts were reviewed by two members of the team (HA and RSH).

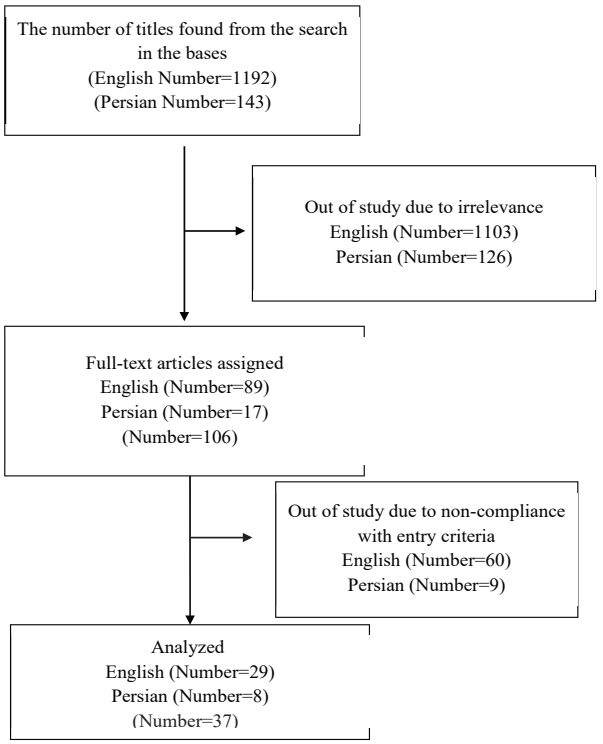

Figure 1: Articles selection process based on the Prisma model (October 2009)

The inter-rater agreement, calculated using Kappa statistics, yielded a significant result (Kappa 0.73), indicating substantial agreement (Landis & Koch, 1977) [17]. Following this initial screening, 39 relevant articles were subjected to thorough examination. Ultimately, 36 eligible studies were selected for inclusion in this study (Figure 1). Among the reviewed articles, 16 randomized controlled trials (RCTs) were clustered at level II.

Quality of Papers: Eight papers were identified as Persian articles (Table 1). Among them, two studies [18, 19] were categorized as level II [20] RCTs (American Academy of Orthopedic Surgery, 2008). Four studies employed purposive sampling and included a control group. At the same time, one article conducted a comparative study, comparing the FIFA 11 warm-up program with its modified version without a control group or comparing FIFA 11+ with a modified version of FIFA 11+ [21]. In the English papers (Table 2), ten studies were classified as RCTs and level II evidence. Two studies [22, 23] utilized randomization and included a control group, while two only had one group. Among the eight studies focused on other sports (Table 3), three cluster RCT studies were categorized as level II evidence (Level II), and four were randomized controlled trials.

Subjects: In most studies, the number of subjects was mentioned, with only two studies [24, 25] reporting the number of teams instead of individual subjects. A total of 10,866 players were included in the reviewed studies, and in those papers reporting the number of teams, a total of 166 teams were investigated. Five studies were conducted exclusively on women, while the remaining included male subjects. It is noteworthy that all subjects in Persian language studies were male.

Since 2008, FIFA "11" has been extensively studied, and the FIFA "11+" program was introduced by Soligard et al. in the same year. Since then, this enhanced FIFA Program has been widely adopted and implemented.

Table 1: Studies about FIFA 11 in Iran

Researcher and year of study	Sample				Method	Intervention	Duration, frequency, severity, and duration of intervention	Result
	Count	Age	Gender	Features				
Sadeghipoor et al 2012 [42]	24 players	19-20 years	Male	Isfahan Clubs	Targeted sampling available to the control group	FIFA 11+	Three times a week, two months	It increases the isometric strength of the quadriceps muscle, which is a factor in preventing injury. However, it did not affect hamstring muscle strength.
Minonezhad et al 2014 [43]	104 players	14-18 years	Male	Tehran League	Case study by comparing two methods	54 players modified 11+ group 50 players 11+ group	24 weeks for 6 months twice a week	Although the FIFA Training Team 11+ was moderated, it was about 43% less likely than FIFA 11+, but this was not statistically significant.
Zarei et al. 2015 [18]	35 team 980 players, control: 476, intervention: 504 players	15-19 years	Male	Iranian youth football	Random-ized controlled clinical trial	FIFA 11+	Twice a week during 30 weeks control group: regular exercises	There were 67383 hours of players' activity and 1220 injuries. The incidence of ankle injuries in the intervention group (65.3 injuries per thousand hours) was lower than that of the control group (6.84)
Zarei et al. 2015 [19]	4 team 66 players, control: 32 intervention: 34 players	14-16 years	Male	Asian Premier League of Vision	cluster random-ized controlled trial (CRCT)	FIFA 11+	In season (30 weeks) control group: regular exercises	Increase the vertical jump of the Sargent, countermovement jump, and anaerobic power of the lower limb muscles of youth soccer players
Ghasemi et al. 2016 [22]	24 players	16-20 years	Male	Youth Football Premier League of Ma-zandaran Province	Random block with control group	12 experimental and 12 FIFA warm-up programs in the experimental group	Three times a week 8 weeks	Neuromuscular features of the lower limb are improved, potentially reducing the risk of ACL injury during landing
Soltandoust nari et al 2017 [23]	30 players	14-16 years	Male	Mashhad teenage foot-ballers	Random with the control group	The FIFA 11+ in the experimental group	3 sessions per week for 8 weeks at evening time for 30 weeks	Reductions in the anterior knee shearing force after performing FIFA 11+ showed a significant difference between the ankle shear force in the training group and the control group
Ebrahimi et al. 2017 [44]	30 players	14 to 16 years	Male	Young soccer players	Random with Control Group	The experimental group performed the FIFA 11+ program	3 times a week for 8 weeks	FIFA 11+ could increase dynamic postural stability by improving neuromuscular coordination and proprioception
Kheiroddin et al., 2017 [21]	111	14-18 years	Male	Tehran League	Case study by comparing two methods	54 players of modified 11+ (adding wobble board) and 57 player control	24 weeks for 6 months twice a week	Despite a 55.88% decrease in the incidence of ankle injuries in the intervention group

Table 2: FIFA 11 and soccer studies

Researcher and year of study	Sample				Method	Intervention	Duration, frequency, severity, and duration of intervention	Result
	Count	Age	Gender	Features				
Kilding and et al. 2008 [26]	24 players	9 to 12 years	-	-	Random with Control Group	12 athletes in the experimental group performed the FIFA 11	5 times a week for 6 weeks.	No injury was observed in the intervention group during the study. Significant increases were also reported in improving performance and preventing injury.
Steffen، and et al. 2008 [9]	34 players	16 to 18 years	Female	High School Football Player	RCT	The effect of FIFA 11 on the prevalence and type of injury in the intervention group	Duration: 15 minutes; 3 times a week for 10 weeks	The intervention did not affect the incidence of injury
Soligard and et al 2008 [10]	2729 players	13 to 17 years	Female	Norway football clubs	Cluster RCT	The effect of FIFA 11+ on the prevalence of lower limb injuries	Duration: 20 minutes; 3 times a week, 8 months	Injuries in the intervention group were 32% lower than in the control group. The risk of injury from excessive use was 53%, and severe injury decreased by 45%.
Soligard and et al 2010 [27]	1055 players	13 to 17 years	Female	-	Cluster RCT	The effect of FIFA 11+ on the prevalence of injury in the experimental group	Duration: 20 minutes; 2 times a week, 8 months	46% less injury in coaches who adhered to the program moderately, and Instructors who had more adherence to the program had 35% fewer injuries in all types of injuries
Brito and et al. 2010 [5]	20 players	18 to 26 years	Male	Semi-Professional	One Group	Effect of the FIFA 11+ in the experimental group	3 times a week; For 8 weeks	The FIFA 11+ program reduces lower limb injury and improves balance and strength
Beijsterveldt and et al 2010 [28]	310 players	18 to 40 years	Male	Amateur High Level	Cluster RCT	control group: 155 athletes, 12 clubs experimental group: 155 athletes, 12 clubs conducted the FIFA 11+	2 to 3 times a week; It was done in a season.	There were no differences in the incidence and severity of injuries in the two groups during the training and the competitions
Junge and et al 2011 [25]	5549 coaches	-	Male	Swiss Football Federation	Cohort study	The effect of education and implementing the FIFA 11+ program in trained teams	Practice twice a week and one match per week.	The injury prevalence in the teams that performed this program was reduced by 11.5% in the competition and 25.3% in the training.
Gatterer and et al 2012 [24]	3 team	-	Male	Amateur	Experiment with Control Group	The experiment group performed the FIFA 11+ program	First half of Italian Amateur League	FIFA 11 is not very effective for middle-level teams
Steffen et al 2013 [29]	266 players	13-18 years	Female	-	Cluster RCT	Impact of the FIFA 11+ warm-up program on the youth soccer team	Duration: 20 minutes; 3 times a week for 4 months	The risk of injury to players with high adherence was 57% lower than the FIFA 11+ program.
Groom et al 2013 [30]	41 players	18-25 years	Male	Academic	Cohort Study	The FIFA 11+ program and its effect on the prevalence of injuries in the intervention group	Duration: 20 minutes; 5-6 times a week for 2 seasons	Reducing the relative risk of lower limb injury by 72% and the time lost to lower extremity damage compared to previous seasons
Owoey، et al. 2014 [31]	416 players	14-19 years	Male	African	Cluster RCT	The FIFA 11+ program and its effect on the prevalence of injuries in the experimental group	Six months each week to evaluate players for injury and loss time	The FIFA 11+ program effectively reduces the overall injury rate by 41 percent for male youth soccer players.
Hamme et al. 2015 [32]	256 players	45 years	Male	Protagonist	Cluster RCT	The FIFA 11+ program and its effect on the prevalence of injuries in the experimental group	9 months, 20 minutes; Once a week for one season	FIFA 11+ injury prevention does not adversely affect veteran players. There was no significant difference between the intervention and control groups.
Silvers-Granelli، et al 2015 [33]	61 team, 1525 players	-	Male	American University League	Cluster RCT	The FIFA 11+ program and its effect on reducing injury	the FIFA 11+ program for 20 minutes 3 times a week throughout the 2012 season	The incidence rate of injury decreased. Also, loss of time was reduced due to injuries, and eventually, the number of players required for treatment also decreased

Takata ، et al. 2016 [34]	11 players	25-33 years	Male	5 Amateur and 6 recreation	One group	investigating changes in muscle activity after part 2 of the FIFA 11+ program	Part 2 of the FIFA 11+ program for 20 minutes for 4 weeks	Part 2 of the FIFA 11+ program for 4 weeks induces changes in muscle activity that may contribute to reducing sports injuries.
Rössler et al. 2016 [35]	20 team, 157 players	Under 9, 11-13 years	Kids and juvenile	Northwest Switzerland	Cluster RCT	Effects of FIFA 11+ Children's and Adolescent Injury Prevention Program on motor function The risk of injury to players with high adherence was 57% lower than the FIFA 11+ program.	15 minutes; Twice a week for 10 weeks	The FIFA 11+ kids have affected physical fitness factors, which can potentially help reduce the risk of injury by improving motor performance.
Silvers-Granelli، et al 2017 [36]	65 team, 1625 players	18-25 years	Male	-	Cluster RCT	Investigating FIFA 11+ on the number of ACL injuries in a quiz or practice, player post, level, and type of ground	15 to 20 minutes; 2-3 times a week before the competition and practice	ACL injury in the match, in all posts, especially the midfield midfielder, in both types of land, artificial and natural grass, especially artificial turf, fell
Saho et al. 2017 [37]	2344 athletes	12–18 years	1815 male 529 female	Adolescent Japanese football players	Cohort study	FIFA 11+ program	2 times a week throughout the intervention seasons	The FIFA 11+ program reduced non-contact injuries and reduced the risk of injury in Japanese female football players.
Nawed et al. 2018 [38]	57 players	18 to 22 years	Male	Amateur soccer players	Random with Control Group	FIFA 11+ experimental group n=29 control group n= 28	5 times a week for 12 weeks	Sprint speed and vertical jump were improved. The FIFA 11+ may improve the performance of young amateur soccer players.
Lopes et al. 2018 [39]	71 players	Aged ≥18 years	Male	Futsal players from 6 amateur clubs	Random with Control Group	34 athletes in the control group and 37 athletes in the intervention group performed the FIFA 11+ program	2 times a week for 10 weeks. 10-week follow-up period	Differences in training exposure, body mass index, weight, flexibility, and sprint. Jump performance,
Gioftsidou et al. 2020 [40]	32 players	18 to 20 years	Young male	soccer players	Random with Control Group	16 control group and 16 intervention group FIFA 11+ (level 2)	Duration: 20-25 minutes; 3 times a week for 8 weeks	Beneficial effects in total stability index and anterior-posterior index, eccentric and concentric strength, and conventional H/Q ratio. improve lower limb equilibrium and the strength of the hamstrings
Arsenis et al. 2020 [41]	32 players	18 to 20 years	Male	young soccer players first Greek division	RCT	The intervention group performed the FIFA 11+ program	3 times a week for 8 weeks	Increasing the balance ability, the concentric strength of the hamstring muscles, and the conventional muscle ratio of soccer players

Regarding other sports, three studies focused on Futsal utilizing the FIFA 11 program. At the same time, a randomized controlled trial was conducted in basketball—additionally, two studies employed modified versions of the FIFA 11+ program in handball.

Most studies reported the effects of the FIFA 11+ program on the prevalence of injury, the assessment of physical fitness, neuromuscular function, and balance, while some studies have included a financial assessment of the FIFA 11+ program, such as its impact, compliance with the plan, or methods of performing. In general, most studies reported a significant reduction in injury. Of course, few studies reported the warming-up program's low or no effect.

Discussion

This systematic review aimed to explore the effectiveness of the 11+ warm-up program in preventing injuries in football and other sports. The review encompassed 793 English-language papers and 98 Persian-language papers. Ultimately, 27 studies met the eligibility criteria, with 12,851 players included in the analysis.

Quality of Papers: This systematic review adhered to the PRISMA statement guidelines (http://www.prisma-statement.org/). Two blinded research team members (RS and HA) independently reviewed and assessed all studies. A third researcher (SA) reassessed the study in case of conflicts. The overall quality of the studies was rated as moderate to high, with 14 studies employing a randomized controlled trial design. In contrast, the remaining studies utilized prospective cohorts or non-randomized experimental designs (rf: Tables 1-3). Among these, 20 studies were classified as at least Level II according to the American Academy of Orthopedic Surgery criteria, indicating relatively good quality. However, many studies faced challenges recruiting sufficient samples, which should be considered in future

Table 3: Studies Fifa 11 and other sports

Researcher and year of study	Sample				Method	Intervention	Duration, frequency, severity, and duration of intervention	Result
	Count	Age	Gender	Features				
Longo et al. 2012 [12]	121 players, 11 teams	11-19 years	Male	Basketball player	Cluster RCT	7 intervention teams and 4 teams in the control group, implementing the FIFA 11+ warm-up program in the experimental group	During a season and 9 months	The FIFA 11+ effectively reduces the injury rate in male elite basketball players. The experimental group (80 players) were significantly less affected than the control group (41 players)
Reisʿ et al., 2013 [45]	36 players	16-18 years	Male	Futsal player	Randomized Cohort study	The FIFA 11+ program in the intervention group	2 times a week for 12 weeks	"FIFA 11+" is an effective practice, meaning it is useful for improving the physical fitness and performance of young futsal players
Grit-sanadilok et al. 2013 [46]	21 players	15-18 years	-	Futsal player	Experiment with the control group	The FIFA 11+ program in the intervention group	10 weeks	FIFA 11+ improves, develops neuromuscular balance, and increases the sense of joint position, which is associated with the prevention of lower extremity injuries in futsal players
Zein et al. 2013 [47]	20 players	15-18 years	Male	Futsal player	Random with the control group	Experimental group: 11+ Control Group: Regular exercises	2 times a week for 4 weeks	FIFA 11+ improves agility, strength, core muscle
Parsons et al. 2017 [48]	47 players	9-11 years	Young female	Develop-mental Indoor Soccer Club	Random with Control Group	FIFA 11+ program	2-3 per week for 5 months	With improved core stability, the 11+ program may not be more effective than other dynamic warmups at improving neuromuscular control and agility.
Abedinza-deh et al 2017 [16]	48 players	-	Male	Handball player	With control group	The experimental group of the modified FIFA 11+ program	3 times a week for 2 months	The FIFA 11+ has been modified to reduce injury rates in male elite handball players. The intervention group players (24 players) were significantly lower than those in the control group (24 players)
Abedinza-deh et al 2019 [49]	48 players	-	Male	Handball player	With control group	The experimental group of the modified FIFA 11+ program	3 times a week for 2 months	The FIFA 11+ is modified by the increase in flexion of the trunk, knee flexion, and knee valgus abnormality in lowering the jump of elite male handball players
Salgues et al. 2021 [50]	64 Players 4 team	16 to 18 years	Young female	Semi-pro-fessional basketball players	Random with two Groups	The FIFA 11+ group adapted to basketball and the PEP group	3 times a week for 9 months	Improvements of the lower limb in strength, agility, symmetry, dynamic valgus, stability, Core Stability, and hip abductor moment. The adapted program for basketball gives more time to the components of strength, plyometrics, and balance

field-based studies. The reviewers found a low risk of bias for allocation concealment and blinding outcome assessment across all domains.

Sample Material: Studies involving male subjects consistently reported a positive impact of FIFA 11+ exercises, except for one study where the sessions were conducted once a week, and the subjects were older, likely due to their high athleticism. Conversely, studies involving female subjects showed a positive effect in cases where the exercises were repeated or implemented over a prolonged duration [10]. In contrast, two studies reported low or no effect, possibly due to weekly meetings [9] or shorter implementation periods spanning half a season [24].

The type and intensity of the exercises: The results of the FIFA 11 warm-up program were not particularly effective or significant until 2008. However, with the program's evolution into "FIFA 11+," as proposed by Soligard et al. in 2008, more impactful results have been reported. The addition of two extra exercises, as well as power training elements such as the Nordic, has notably reduced injuries.

In the study by Soligard et al. (2008), 376 injuries were recorded, with 215 cases occurring in the control group and 161 cases in the experimental group. The authors noted significant differences between the two groups regarding the number of knee injuries and a reduction in the risk of injury during tournaments and practice sessions. Two years later, in another study by the same group led by Soligard in 2010, it was observed that the

risk of injury was lower in the group that participated more actively in the program compared to athletes with a moderate level of participation. Additionally, instructors who had fully embraced and implemented the program witnessed a 46% reduction in injuries compared to those who showed moderate commitment. Furthermore, instructors who demonstrated higher adherence to the program reported a 35% decrease in injuries [10].

One notable study demonstrating the effectiveness of the 11+ program was conducted by Jang et al. (2011) [25]. In this study, following implementing a nationwide campaign aimed at reducing injuries among amateur soccer players in Switzerland, there was a notable decrease in injury rates, with a reduction of 11.5% during matches and 25.3% during training sessions. The authors attributed this success to the successful implementation of the program across the country, resulting in fewer soccer-related injuries among amateur athletes and a consequent reduction in medical expenses. According to Swiss National Insurance Company data, 42,260 soccer-related injuries were reported in 2003, amounting to $130 million in treatment costs. The study findings underscore the potential effectiveness of a nationwide campaign to implement such warm-up programs, leading to tangible reductions in injuries and associated treatment costs.

Moreover, several review papers [51, 52] and meta-analyses published in recent years [53] have further corroborated the effectiveness of the 11+ program in reducing injuries across various anatomical areas of the body.

Impact of the program: Among the 36 studies included in our review, 22 directly investigated the reduction of injuries, while others explored various effects of the FIFA 11 warm-up program on factors such as changes in muscle activity [34], muscular strength [40-42, 50], and physical fitness [35, 38-41, 45, 47, 48, 50], as well as the reduction of knee shearing force [23].

Four studies reported either no influence or a low impact of the FIFA 11 warm-up program. These studies focused on amateur soccer or futsal players, where the timing or duration of FIFA 11 training was limited (e.g., one session per week or half a season), or the program was not modified for futsal. Nonetheless, these studies suggested that increasing the intensity and duration of the program training may lead to more favorable outcomes [28].

The study by Beijsterveldt et al. (2011) found no significant difference in injury occurrence or severity among athletes who performed the FIFA 11 warm-up program. They recommended that future studies consider the exercise's duration and intensity, suggesting that these factors could influence the program's effectiveness. Another study by Stefan et al. (2008) [9] also reported a lack of impact of the FIFA 11 program. Their findings may be attributed to low adherence to the program among teams in the intervention group and insufficient training sessions (only one session per week). Therefore, the authors suggested that the low adherence to the program likely contributed to the lack of reduced injury rates. In a follow-up study, Stefan et al. (2013) criticized the FIFA-provided program, noting that it fails to offer sufficient motivation for athletes to adhere to the program consistently throughout the season, which could lead to decreased adherence and, consequently, diminished effectiveness.

Therefore, it is crucial for coaching staff and athletes to recognize the significance of such exercises in injury prevention and to adhere to the prescribed programs diligently. These limitations can be addressed by enhancing awareness among coaches and athletes regarding the program's benefits. Furthermore, adjusting the program to make it more appealing and suitable for the teams' fitness levels could encourage greater adherence. It is suggested that educational workshops be conducted periodically to increase educators' understanding of injury prevention benefits and familiarity with the FIFA 11+ program. Educated and trained educators in this regard can help reduce injury incidents, enhance efficiency, and improve players' performance. Additionally, it is recommended to customize the FIFA 11+ program for other sports to suit specific sport-related factors such as field type, injury prevalence, and mechanisms.

Iranian Studies

Studies in Iran have been conducted since 2012, primarily focusing on male athletes. Most of these studies have involved skilled players in the national league, except one study [23] that involved adolescents, although the players' skill levels were not specified. Among these studies, four have examined the effectiveness of the FIFA 11 warm-up program in reducing injuries [18, 19, 21, 43]. Additionally, other studies have explored the program's effects on increasing muscle strength [42], improving muscle nervous function [22], enhancing proprioception and neuromuscular coordination [44], and reducing knee shearing force [23].

FIFA 11 in Other Sports

The FIFA 11+ program has been adapted and implemented in sports, such as basketball, handball, and futsal, as summarized in Table 3. In basketball, a Cluster RCT demonstrated that the FIFA 11+ program effectively reduced injuries among elite players [12]. Salgues et al. (2021) [50] also reported improvements in various physical fitness factors, indirectly contributing to injury prevention. Among futsal players, four studies implementing the FIFA 11+ program observed enhancements in physical fitness components, including strength, agility, joint position sense, balance, and core stability, all of which are crucial for injury prevention [45-48].

In handball, a modified version of the FIFA 11+ program reduced injury rates by influencing kinetic and kinematic factors such as jump height, power, and balance, as well as increasing trunk and knee flexion angles and reducing knee valgus during landing among elite handball players [16, 49].

Conclusion

The analysis of studies indicates that implementing the FIFA 11 warm-up program for preventing sports injuries has yielded positive effects, notably reducing the risk of injury and enhancing overall safety in sports.

Integrating this program into regular training routines can be done seamlessly without consuming significant time. However, it is paramount in enhancing physical fitness, mitigating injury risks, and expediting the return to play process after an injury, ultimately contributing to improved performance among soccer players.

It is important to acknowledge that one-size-fits-all approaches may not yield identical results across diverse groups, whether amateur or professional. Thus, the intensity and duration of such programs should be optimized based on specific needs and contexts. Additionally, there is a pressing need for tailored injury prevention programs for various sports. Future research endeavors should prioritize investigating the implementation of the FIFA 11+ program, with a focus on customization for different sports, while considering factors such as the skill level, gender, and age of the participants.

Acknowledgment

The stimulating enthusiasm of the late Mahdieh Akoochakian was indispensable in setting-up the study.

Conflict of Interest: None declared.

References

1. Wong P, Hong Y. Soccer injury in the lower extremities. British journal of sports medicine. 2005;39(8):473-82.
2. Sharifatpour R, Akochakian M, Alizadeh MH, Abbassi H. Prevalence and mechanism of injuries in Male Beach soccer players. Journal of community health research. 2020;9(3):184-90.
3. Hawkins RD, Hulse M, Wilkinson C, Hodson A, Gibson M. The association football medical research programme: an audit of injuries in professional football. British journal of sports medicine. 2001;35(1):43-7.
4. Pafis G, Ispirlidis I, Godolias G. Balance training programs for soccer injury prevention. Physical Training. 2007;2(1):1-11.
5. Brito J, Figueiredo P, Fernandes L, Seabra A, Soares JM, Krustrup P, et al. Isokinetic strength effects of FIFA's" The 11+" injury prevention training programme. Isokinetics and Exercise Science. 2010;18(4):211-5.
6. Ekstrand J, Gillquist J. The frequency of muscle tightness and injuries in soccer players. The American journal of sports medicine. 1982;10(2):75-8.
7. Ekstrand J, Gillquist J. Theavoidability of soccer injuries. Int J Sport s Med. 1983;4:124-8.
8. Junge A, Rösch D, Peterson L, Graf-Baumann T, Dvorak J. Prevention of soccer injuries: a prospective intervention study in youth amateur players. The American journal of sports medicine. 2002;30(5):652-9.
9. Steffen K, Myklebust G, Olsen OE, Holme I, Bahr R. Preventing injuries in female youth football–a cluster-randomized controlled trial. Scandinavian journal of medicine & science in sports. 2008;18(5):605-14.
10. Soligard T, Myklebust G, Steffen K, Holme I, Silvers H, Bizzini M, et al. Comprehensive warm-up programme to prevent injuries in young female footballers: cluster randomised controlled trial. Bmj. 2008;337.
11. Rahnama N, Bambaeichi E, Daneshjoo A. The epidemiology of knee injuries in Iranian male professional soccer players. Sport Sciences for Health. 2009;5:9-14.
12. Longo UG, Loppini M, Berton A, Marinozzi A, Maffulli N, Denaro V. The FIFA 11+ program is effective in preventing injuries in elite male basketball players: a cluster randomized controlled trial. The American journal of sports medicine. 2012;40(5):996-1005.
13. Wedderkopp N, Kaltoft M, Lundgaard B, Rosendahl M, Froberg K. Prevention of injuries in young female players in European team handball. A prospective intervention study. Scandinavian journal of medicine & science in sports. 1999;9(1):41-7.
14. Wedderkopp N, Kaltoft M, Holm R, Froberg K. Comparison of two intervention programmes in young female players in European handball–with and without ankle disc. Scandinavian journal of medicine & science in sports. 2003;13(6):371-5.
15. Olsen O-E, Myklebust G, Engebretsen L, Holme I, Bahr R. Exercises to prevent lower limb injuries in youth sports: cluster randomised controlled trial. Bmj. 2005;330(7489):449.
16. Abedinzadeh S, Sahebozamani M, Amirseyfaddini M, Abbasi H. Effect of 8 weeks of injury prevention training of modified FIFA 11+ on kinetics indices of vertical jump on elite handball players. Pharmacophore; 2017;8(6S), e-1173382.
17. Landis JR, Koch GG. The measurement of observer agreement for categorical data. biometrics. 1977:159-74.
18. Zarei M, Alizadeh MH, Alizadeh S. The Effect of FIFA Comprehensive Warm Up Program "11+" for the Prevention of Ankle Injuries in Soccer Players: A Prospective Randomized Controlled Trial. Journal of Research in Rehabilitation Sciences. 2015;11(2):146-54.
19. Zarei M. FIFA 11+ Warm-Up Program Reduce Injuries Incidence Rate in Iranian Young Male Soccer Players. Studies in Sport Medicine. 2015;7(17):50-35.
20. Surgeons AAoO. Levels of evidence for primary research question. Accessed; 2008.
21. Kheiroddin F, Minoo Nejad H, Alizadeh MH. Effects of the Modified 11+ Warm up Program on Lower Extremity Injuries Prevention among Young Male Footballers. Studies in Sport Medicine. 2017;9(21):29-42.
22. Ghasemi Paeendehi V, Shojaeddin S, Ebrahimi-Tekamejani E, Letafatkar A, Eslami M. The Effects of 8 Weeks of FIFA11+ Warm-Up Program on Timing and Electromyography Activity of Knee Muscles to Prevent the ACL Injury. Sport Sciences and Health Research. 2016;8(2):175-95.
23. Soltandoost NSM, Ebrahimi AA, Khoshraftar YN. Effect of FIFA 11+ Injury prevention program on anterior knee shear force in teenage male soccer players. 2017;6(1):1-9.
24. Gatterer H, Ruedl G, Faulhaber M, Regele M, Burtscher M. Effects of the performance level and the FIFA "11" injury prevention program on the injury rate in Italian male amateur soccer players. J Sports Med Phys Fitness. 2012;52(1):80-4.
25. Junge A, Lamprecht M, Stamm H, Hasler H, Bizzini M, Tschopp M, et al. Countrywide campaign to prevent soccer injuries in Swiss amateur players. The American journal of sports medicine. 2011;39(1):57-63.
26. Kilding AE, Tunstall H, Kuzmic D. Suitability of FIFA's "The 11" training programme for young football players–impact on physical performance. Journal of sports science & medicine. 2008;7(3):320.
27. Soligard T, Nilstad A, Steffen K, Myklebust G, Holme I, Dvorak J, et al. Compliance with a comprehensive warm-up programme to prevent injuries in youth football. British journal of sports medicine. 2010;44(11):787-93.
28. van Beijsterveldt AM, Krist MR, Schmikli SL, Stubbe JH, de Wit GA, Inklaar H, et al. Effectiveness and cost-effectiveness of an injury prevention programme for adult male amateur soccer players: design of a cluster-randomised controlled trial. Injury prevention. 2011;17(1):e2-e.
29. Steffen K, Meeuwisse WH, Romiti M, Kang J, McKay C, Bizzini M, et al. Evaluation of how different implementation strategies of an injury prevention programme (FIFA 11+) impact team adherence and injury risk in Canadian female youth football players: a cluster-randomised trial. British journal of sports medicine. 2013;47(8):480-7.
30. Grooms DR, Palmer T, Onate JA, Myer GD, Grindstaff T. Soccer-specific warm-up and lower extremity injury rates in collegiate male soccer players. Journal of athletic training. 2013;48(6):782-9.
31. Owoeye OB, Akinbo SR, Tella BA, Olawale OA. Efficacy of the FIFA 11+ warm-up programme in male youth football: a cluster randomised controlled trial. Journal of sports science & medicine. 2014;13(2):321.
32. Hammes D, Aus der Fünten K, Kaiser S, Frisen E, Bizzini M, Meyer T. Injury prevention in male veteran football players–a randomised controlled trial using "FIFA 11+". Journal of sports sciences. 2015;33(9):873-81.
33. Silvers-Granelli H, Mandelbaum B, Adeniji O, Insler S, Bizzini M, Pohlig R, et al. Efficacy of the FIFA 11+ injury prevention program in the collegiate male soccer player. The American journal of sports medicine. 2015;43(11):2628-37.
34. Takata Y, Nakase J, Inaki A, Mochizuki T, Numata H, Oshima T, et al. Changes in muscle activity after performing the FIFA 11+ programme part 2 for 4 weeks. Journal of sports sciences. 2016;34(20):2011-7.
35. Rössler R, Donath L, Bizzini M, Faude O. A new injury prevention programme for children's football–FIFA 11+ Kids–can improve

motor performance: a cluster-randomised controlled trial. Journal of sports sciences. 2016;34(6):549-56.
36. Silvers-Granelli HJ, Bizzini M, Arundale A, Mandelbaum BR, Snyder-Mackler L. Does the FIFA 11+ injury prevention program reduce the incidence of ACL injury in male soccer players? Clinical Orthopaedics and Related Research®. 2017;475:2447-55.
37. Saho Y, Kato H, Chikako N, Ikeda H, Fukubayashi T. The Efficacy of Fifa 11+ over a 6-Year Period, in Adolescent Football Players. British Journal of Sports Medicine. 2017;51(4):381-.
38. Nawed A, Khan IA, Jalwan J, Nuhmani S, Muaidi QI. Efficacy of FIFA 11+ training program on functional performance in amateur male soccer players. Journal of back and musculoskeletal rehabilitation. 2018;31(5):867-70.
39. Lopes M, Simões D, Rodrigues JM, Costa R, Oliveira J, Ribeiro F. The FIFA 11+ does not alter physical performance of amateur futsal players. The Journal of Sports Medicine and Physical Fitness. 2018;59(5):743-51.
40. Gioftsidou A, Arsenis S, Ispyrlidis I, Pafis G, Barbas I, Malliou P, et al. The Effects of FIFA 11+ Injury Prevention Program on Lower Limbs Strength and Balance. Экстрабилити как феномен инклюзивной культуры: формирование инклюзивной культуры в организациях—Екатеринбург, 2020:57-64.
41. Arsenis S, Gioftsidou A, Ispyrlidis I, Kyranoudis A, Pafis G, Malliou P, et al. Effects of the FIFA 11+ injury prevention program on lower limb strength and balance. Journal of Physical Education and Sport. 2020;20(2):592-8.
42. Sadeghipour HR, Rahnama NR, Daneshjoo A, Bambaeichi E. The effect of Fifa 11+ injury prevention program on hamstrings and quadriceps isometric muscle strength in Iranian young professional soccer players. Journal of Research in Rehabilitation Sciences. 2013;8(6):1113-22.
43. Minoonejad H, Kheiroddin F, Alizadeh MH, panahibakhsh M, Zareeii M. Comparison of the effects of modified FIFA 11+ Program and FIFA 11+ on the prevention of lower extremity injuries in young male soccer players. Journal for Research in Sport Rehabilitation. 2014;2(3):1-9.
44. Ebarahimi AA, Baharifard R, Khoshraftar N. Effect of FIFA 11+ injury prevention program for eight weeks on the dynamic postural stability of teenage male soccer players in single-leg jump-landing exercises. 2017;5(2):79-88.
45. Reis I, Rebelo A, Krustrup P, Brito J. Performance enhancement effects of Federation Internationale de Football Association's "The 11+" injury prevention training program in youth futsal players. Clinical journal of sport medicine. 2013;23(4):318-20.
46. Gritsanadilok W, Chentanez T, Hirunrat S, Sinphurmsuksakul O. The effect of "the fifa 11+" warm-up training on balance and proprioception in adolescent futsal players. Journal of Sports Science and Technology. 2013;12(2):318-20.
47. Zein MI, Kurniarobbi J, Prastowo NA, Mukti IL. The effect of short period FIFA 11+ training as an injury prevention program in youth futsal players. Int J Phys Educ Sport Health. 2017;4(2):200-3.
48. Parsons JL, Stenberg H, Carswell J. FIFA 11+ Warm-up: Effects On Movement Control And Performance In Young Female Soccer Athletes: 2084 Board# 97 June 1 3: 30 PM-5: 00 PM. Medicine & Science in Sports & Exercise. 2017;49(5S):573.
49. Abedinzadeh S, Sahebalzamani M, Amir Seyfaddini M, Abbasi H. Effect of Training Modified FIFA 11+ on Kinematic Factors of Landing in Elite Handball Players. Journal of Paramedical Sciences & Rehabilitation. 2019;8(1):45-57.
50. Salgues N. Efectividad del programa Fifa 11+ adaptado a jugadoras de baloncesto entre los 16 y los 18 años que evolucionan en centros de formación para la prevención de rupturas del LCA mediante la intervención sobre los factores de riesgo en comparación con el programa PEP: ensayo clínico aleatorizado simple ciego propuesta de intervención: Salut-UVic; 2021.
51. Barengo NC, Meneses-Echávez JF, Ramírez-Vélez R, Cohen DD, Tovar G, Correa Bautista JE. The impact of the FIFA 11+ training program on injury prevention in football players: a systematic review. International journal of environmental research and public health. 2014;11(11):11986-2000.
52. Bizzini M, Dvorak J. FIFA 11+: an effective programme to prevent football injuries in various player groups worldwide—a narrative review. British journal of sports medicine. 2015;49(9):577-9.
53. Gomes Neto M, Conceição CS, de Lima Brasileiro AJA, de Sousa CS, Carvalho VO, de Jesus FLA. Effects of the FIFA 11 training program on injury prevention and performance in football players: a systematic review and meta-analysis. Clinical rehabilitation. 2017;31(5):651-9.

JRSR 11 (2024) 70-75

Journal of Rehabilitation Sciences and Research

Journal Home Page: jrsr.sums.ac.ir

Original Article

Assessing Physiotherapists' Knowledge of Professional Ethics Codes in Shiraz: A Cross-Sectional Study

Marzieh Mohamadi[1], PhD; Hossein Mahmoodian[2*], PhD; Narges Meftahi[1], PhD; Zahra Rahmanian[1], BSc

[1]Department of Physiotherapy, School of Rehabilitation Sciences, Shiraz University of Medical Sciences, Shiraz, Iran
[2]Department of Medical Ethics, School of Medicine, Shiraz University of Medical Sciences, Iran

ARTICLE INFO

Article History:
Received: 28/09/2022
Revised: 02/05/2023
Accepted: 14/06/2023

Keywords:
Codes of ethics
Professional ethics
Ethical knowledge
Physiotherapy
Iran

Please cite this article as:
Mohamadi M, Mahmoodian H, Meftahi N, Rahmanian Z. Assessing Physiotherapists' Knowledge of Professional Ethics Codes in Shiraz: A Cross-Sectional Study. JRSR. 2024;11(2):70-75. doi: 10.30476/JRSR.2023.96868.1327.

ABSTRACT

Background: Understanding the principles of professional ethics is crucial for physiotherapists as it equips them to navigate ethical dilemmas effectively. This study aimed to assess the awareness level of physiotherapists in Shiraz regarding the ethical principles outlined in the codes of professional ethics within the field of physiotherapy.

Methods: To carry out this cross-sectional study, a checklist comprising 20 items was developed and distributed to 163 physiotherapists practicing in Shiraz. Each item was scored using a 5-point Likert scale. The checklist allowed for a maximum score of 100 and a minimum score of 20.

Results: Out of the 163 physiotherapists approached, 109 completed the checklist. The mean score this study's participating physiotherapists achieved was 80.1±6.5. The mean score showed correlations with both age (r_s=0.9, P<0.001) and clinical experience (r_s=0.32, P<0.001) of the physiotherapists. No significant differences were observed in the level of awareness of professional ethics codes between genders (P=0.99) or among those working in private, public, or mixed sectors (P=0.39).

Conclusion: Overall, the findings of this study indicate that the awareness level of Shiraz physiotherapists regarding the codes of professional ethics is generally good. However, certain codes may benefit from further training and emphasis.

Introduction

Virtues and ideals, such as caring for others, can sometimes seem ambiguous in their meaning. While it's often said that individuals should embody qualities like kindness and compassion, the practical application of these virtues may lack clarity. Therefore, having clear principles and rules becomes essential in defining the significance of these virtues. Especially in healthcare settings, where ethical relationships are paramount, it's important to recognize the guidance provided by several fundamental ethical principles widely utilized in biomedical ethics. Four principles are particularly significant: respect for autonomy, beneficence, non-maleficence, and justice [1].

Patient rights are essentially a subset of human rights. Human rights delineate the minimum standards and practices that individuals can rightfully expect from others. Conversely, ethics revolves around the conventional criteria dictating how individuals should treat one another. Hence, law and morality often intersect, representing two facets of the same principle. By elucidating patient rights, healthcare endeavors to standardize care, ensuring that patients maintain consistent expectations throughout their treatment [2].

Patients have the inherent right to receive essential treatments regardless of gender, age, or financial status. Moreover, their fundamental rights, including autonomy,

*Corresponding author: Hossein Mahmoodian, PhD; Department of Medical Ethics, School of Medicine, Zand Street, Postal code: 71348-45794, Shiraz, Iran. **Tel:** +98 71 32307880; **Fax:** +98 71 32359847; **Email:** mahmoodian@sums.ac.ir

human dignity, and privacy, must be upheld, considering their cultural, psychological, and spiritual values. Upholding patient rights necessitates the delivery of care that is of high quality and administered with respect [3, 4].

As outlined in the Patient Bill of Rights, healthcare institutions and professionals uphold these rights and principles per established national and international laws [4]. Professional ethics encompass the guiding principles of appropriate conduct concerning the rights and responsibilities of practitioners, interactions with patients and peers, and professional and interpersonal relationships with the patient's family [5].

Since 1935, national and international associations have developed specific codes of ethics for physical therapy [6]. For instance, the American Physical Therapy Association (APTA) has outlined eight principles encompassing 38 ethical recommendations to establish a foundation for practice integrity within its membership [7]. Similarly, the Australian Physiotherapy Association (APA) has delineated nine principles and 59 recommendations for professional conduct [8]. At the same time, the World Confederation of Physiotherapy (WCPT) expects physiotherapists to adhere to 8 principles and 40 recommendations in good practice [9].

It is imperative to tailor ethical codes in medical sciences to each society's beliefs, values, and moral principles. Given that the Iranian constitution underscores the importance of morality, and the first article of the country's civil law echoes this sentiment, along with the general policies of the system in the field of health emphasizing ethics, it's evident that the need for ethics in the Islamic Republic of Iran's system is paramount. Numerous ethical guidelines, including those from the Medical System Organization and specific ethics guidelines in the country's medical science research, further underscore this need.

Since ethics aims to ensure compliance with treatment, research, and education standards, the initial step toward achieving this objective is offering guidance and guidelines. In Iran, codes of ethics in the field of physiotherapy encompass principles compiled into three sections: "Ethics in Providing Physiotherapy Services," "Ethics in Physiotherapy Research," and "Ethics in Physiotherapy Education." Each section comprises various chapters and axes [10].

Over the years, physical therapists have pursued a more autonomous role in clinical decision-making within the healthcare system [11, 12]. Leaders in physiotherapy have repeatedly emphasized that increased autonomy brings about more complex ethical dilemmas and responsibilities [13-17]. Magistro cautioned in 1989: " As physical therapists assume a more independent role in providing health care, ethical judgments will play an important role in the scope of physical therapist clinical decision-making " [13]. With the evolution of the medical field, the profession of physical therapy transitioned from a technical discipline to a professional one, and the code of ethics of physical therapy became a document that emphasized the therapist's primary responsibility directly to the patient, independent of the physician [18]. Today, physiotherapists must assess their profession ethically to determine the boundaries of their legal and professional independence. In doing so, they conscientiously safeguard patients' rights, uphold their integrity as professionals, and advance the ideals of physical therapy as a profession [17].

Ethically safe care is a paramount objective in healthcare globally [19], and codes of professional ethics serve several crucial purposes; they can elucidate ethical concerns or dilemmas, foster collaboration among members of the profession, instruct and steer ethical decision-making and conduct, promote public accountability, and align with societal expectations [20]. Therefore, physiotherapists must grasp the tenets of professional ethics in their domain, enabling them to navigate ethical quandaries adeptly. Given that familiarity with the principles of professional ethics has recently been incorporated into the educational curriculum of physiotherapy, it's presumed that practicing physiotherapists may not possess sufficient familiarity with the profession's codes of professional ethics.

Based on our research, only two studies have investigated the awareness of physiotherapists about ethical principles in Iran. The first study, conducted in 2009 in Tabriz city, and the second study, conducted in 2016 in Tehran city, did not specifically investigate the level of awareness of physiotherapists about the ethical codes specific to the field of physiotherapy [21, 22]. In the first study, the questionnaire's questions were designed based on various aspects of patient rights. Still, other aspects, such as the rights of therapists, colleagues, institutions, and societal rights, were not considered. In the second study, a questionnaire was not utilized; participants were interviewed, and their opinions were sought. Since the questions were posed in an open-ended manner, covering general topics initially and then delving into more specialized ones based on participants' responses, there is a possibility that not all aspects of ethical codes were addressed. Therefore, it can be concluded that systematic studies on the awareness of ethical codes among physical therapists have not been conducted.

At the global level, ethical practice and awareness are paramount in physiotherapy as a clinical profession, garnering attention since the pre-2000s era. Previous studies have underscored the necessity of assessing professionals' awareness and, where necessary, providing training [17, 23, 24]. However, our search yielded no studies on determining the level of awareness among physiotherapists in Shiraz regarding the principles of professional ethics. Consequently, this study was undertaken to investigate the level of awareness among physiotherapists in Shiraz concerning the principles of professional ethics in their field.

In this study, our objective was to assess the level of awareness among physiotherapists in Shiraz regarding the ethical principles outlined in the codes of professional ethics in physiotherapy. Given the potential physiological and psychological distinctions between genders, it was conceivable that women and men might exhibit varying performances and cognitive approaches to moral matters. Additionally, the work environment, training provisions, and supervision protocols in public and private

settings could influence therapists' comprehension and performance concerning ethical issues. Furthermore, age and clinical experience might shape individuals' understanding due to accrued experiences. Consequently, the current study compared the level of knowledge between two groups: men and women and professionals from the public and private sectors. Moreover, the study investigated the correlation between professionals' level of knowledge and their age and clinical experience.

Methods

The present study is a descriptive cross-sectional investigation conducted in Shiraz City. Approval for the research was obtained from the Shiraz University of Medical Sciences ethics committee under code IR.SUMS.REHAB.REC.1401.004. A checklist titled "Checklist for Assessing the Level of Awareness of Physical Therapists Regarding the Codes of Professional Ethics in Physical Therapy" was used for data collection. This checklist was meticulously crafted based on the established codes of professional ethics within physiotherapy. The target population comprised physiotherapists across Shiraz City's private and public sectors. The primary variable under scrutiny was the level of awareness among physiotherapists concerning the codes of professional ethics. Additionally, to glean further insights, the study explored potential relationships between three variables: age, gender, clinical work experience, employment sector (private, public, or both), and the level of awareness.

The checklist was meticulously designed based on the principles of professional ethics developed in Iran [10]. It encompassed 20 items carefully selected from the codes of professional ethics within physiotherapy. The goal was to ensure the checklist encompassed all clauses from the compiled version of professional ethics principles and incorporated most of the codes of ethics. Some items mirrored the original version of the code of ethics, while others presented the code of ethics in a reverse manner. The checklist was collaboratively prepared by a team of three individuals, comprising a medical ethics expert (assistant professor of the medical ethics department) and two physiotherapy experts (assistant professors of the physiotherapy department). Subsequently, a 5-point Likert scale was assigned to each item. Participants were tasked with selecting one of the available options (I completely agree, I agree, I have no opinion, I disagree, I completely disagree) to indicate their level of agreement with the respective item.

To facilitate the study, the designed checklist was digitized and made accessible online via the Porsline system. Utilizing the Shiraz University of Medical Sciences database, we obtained a list comprising the names and mobile phone numbers of all physiotherapists operating in Shiraz City. Initially, 220 phone numbers were procured, but after filtering out duplicates and inactive numbers, 163 remained. Adhering to ethical standards, each phone number was contacted, and the study procedure was explained to the individuals. Participants were assured of the confidentiality of their personal information, including their name, phone number, and responses to the checklist. They were informed that their participation was voluntary. Those willing to participate in the study were provided a link to access the checklist online. Subsequently, 109 individuals out of the initial 163 completed the checklist.

The checklist designated "completely agree" as the correct response for items corresponding to the code of ethics. At the same time, "completely disagree" was considered correct for items inversely related to the code of ethics. Each correct response earned 5 points, while others received fewer points. With a maximum score of 100 and a minimum score of 20, the mean score for each checklist item was calculated upon collection.

Physiotherapists were categorized into age groups (20-35 years, 36-50 years, and over 50 years) and clinical experience groups (1-10 years, 11-20 years, and over 20 years) to analyze the frequency distribution. Pearson correlation test was employed to assess the correlation between age/clinical work experience and knowledge level. Furthermore, to compare knowledge levels between male and female physiotherapists and those working in private, public, or both sectors, Mann-Whitney and Kruskal-Wallis tests were utilized, respectively.

Results

The mean score of the participating physiotherapists in this study was 80.1±6.5 with 95% CI (81.3-78.8). Table 1 shows the mean scores and standard deviation obtained in the different groups examined in this study.

The checklist included 20 items, each receiving a score between 1 and 5. The mean score obtained in each item is shown in Figure 1.

The results of the Spearman test indicate a significant positive correlation between the mean score obtained and both the age (r_s=0.9, P<0.001) and the clinical work

Table 1: The scores obtained from the checklist in the different groups studied

	Group	Number	Mean±SD
Sex	Female	65	80.2±6.2
	Male	44	79.8±7.1
Age range (Y/O)	20 to 35	54	78.5±6
	36 to 50	39	81.2±6.7
	>50	16	82.7±6.9
Experience (years)	1 to 10	60	78.5±6.1
	11 to 20	29	81.3±6.5
	>20	20	82.8±6.8
Sector	Private	72	80.7±6.8
	Public	14	79.2±4.5
	Both	23	78.6±6.8

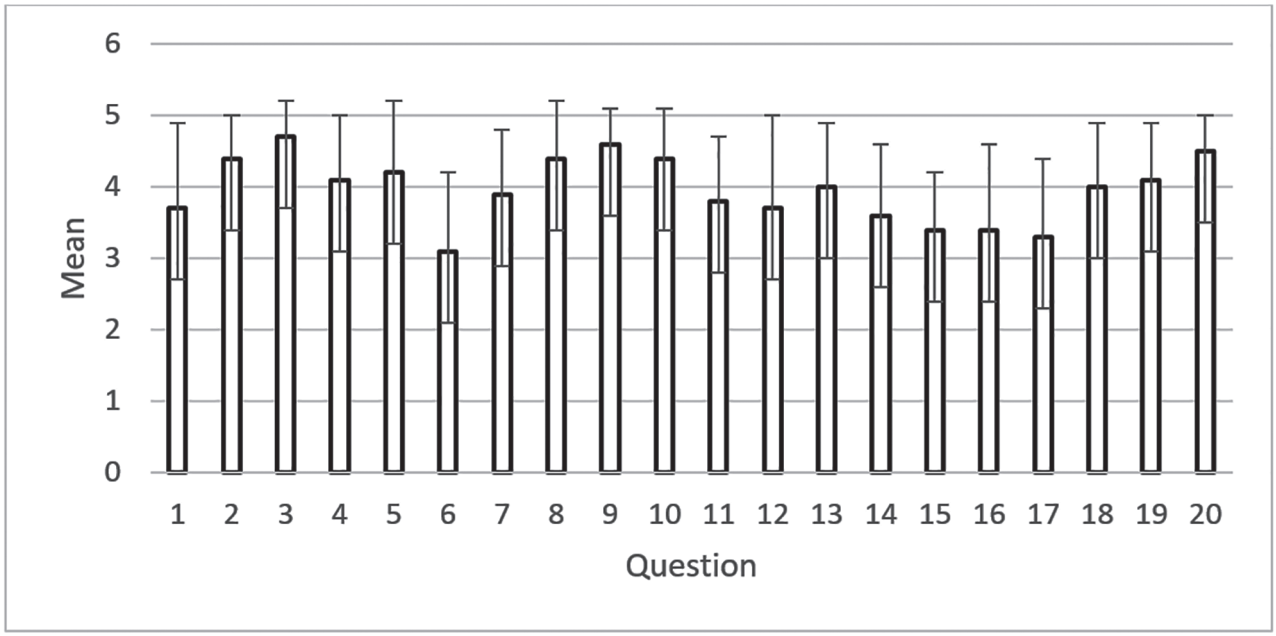

Figure 1: The mean score obtained for each item on the checklist

experience (r_s=0.32, P<0.001) of the physiotherapists. This suggests that older physiotherapists with more clinical experience tend to have a higher level of awareness regarding professional ethics codes.

Additionally, the analysis showed no significant difference in the level of knowledge of professional ethics codes between male and female physiotherapists (P=0.99), nor among those working in the private, public, or both sectors (P=0.39). This suggests that gender and employment sectors do not significantly influence the awareness of professional ethics codes among physiotherapists in Shiraz.

Discussion

The findings of this research indicate a positive assessment of the level of awareness of physiotherapists in Shiraz regarding professional ethics codes. While the overall awareness level is deemed "good," it's noteworthy that there were variations in the level of awareness across different checklist items. Specifically, 11 out of 20 items received a "good" grade, while nine received a "moderate" grade.

Importantly, the study found no significant disparity in the knowledge of professional ethics codes between male and female physiotherapists, nor among those working in different sectors (private, public, or both). However, there was a notable correlation between the age and clinical work experience of physiotherapists and their level of awareness of professional ethics codes. Older physiotherapists with more clinical experience tended to exhibit a higher level of awareness regarding ethical codes.

The findings of this study showed that physiotherapists obtained a moderate score from the items related to the following ethical codes:

• Professionals must refer patients to therapists and other qualified specialists when necessary, and they should not seek financial gain from such referrals.

• Professionals must honor patient privacy and avoid conducting examinations in shared spaces. Additionally, they should endeavor to provide adequate patient coverage for privacy during examinations.

• Professionals are responsible for ensuring that patients comprehend the nature of the services offered and are informed about the anticipated costs before any service is rendered.

• Professionals must honor patients' information, choice, and decision-making rights.

• Professionals must empathize with patients, avoid indifference, and control their emotions and reactions.

• Professionals are mandated to deliver suitable services to all individuals seeking rehabilitation, regardless of age, gender, race, ethnicity, nationality, religion, ideology, moral convictions, personal inclinations, political views, disabilities, and health conditions.

• In allocating human and capital resources, adhering to principles of justice is imperative. When resources are limited, it is essential to prioritize based on the guidelines established by clinical ethics committees affiliated with medical universities (Physiotherapy Scientific Association).

• Professionals are not entitled to offer services deemed unnecessary for the patient's condition.

• Professionals must courteously notify the relevant colleague of a scientific or technical error made by their peers and, upon request, furnish details about the error to the patient or their legal representative. They are also expected to offer support and assistance in such situations.

Given that the level of awareness among physiotherapists regarding certain ethical codes is deemed "moderate," there appears to be a requirement for additional training about these codes. These areas encompass ethical principles such as "respecting human dignity rights," "observing justice and equity," "prioritizing patient interests and avoiding harm," "social responsibility," and "ethical conduct concerning colleagues." [10]. It is evident that among the six chapters outlining professional ethics codes, there is a discernible necessity for further

training across five domains.

The findings of this study revealed a positive correlation between the age and clinical experience of physiotherapists and their awareness of professional ethics codes. These results align with the findings of Myyrya et al. [25]. They observed a negative correlation between age and personal interest scores in their investigation into empathy, role-taking, and personal values as predictors of moral schemas. In contrast, a positive correlation was found with post-conventional schema thinking scores. Furthermore, age was positively associated with role-taking, universalism, and self-orientation while negatively impacting hedonism, achievement, and power. Notably, disparities between men and women were identified in personal interest scores and post-conventional thinking scores [25].

On the contrary, our findings diverge from those reported by Tiruneh and Ayele in 2018 [26]. Their study, focusing on Ethiopian doctors, revealed that only 30.4% of doctors demonstrated ethical practice. Interestingly, ethical performance was higher among doctors aged 25 to 29 compared to those aged 30 to 34, and doctors employed in the private sector exhibited better moral performance than their counterparts in the public sector. The disparity between the outcomes of the two studies might stem from the difference in the methodologies employed. In contrast, our study assessed the level of awareness of ethics codes, and Tiruneh and Ayele evaluated ethical performance [26].

It is commonly observed that individuals tend to approach a plateau in terms of professional ethics as they reach a certain age [27]. James Rest's four-element model provides a widely accepted framework for assessing the psychological processes involved in moral behavior. The elements identified by Rest include 1) moral sensitivity (the interpretation of the situation); 2) moral judgment (the ability to distinguish morally right from wrong actions); 3) moral motivation (prioritizing moral virtues over other considerations); and 4) moral character (possessing qualities such as courage, loyalty, the ability to overcome distractions, and effective execution skills). This model posits that although these underlying psychological processes interact, they are distinct. Moral reasoning is the most prominent element in the Rest model, with cognitive development significantly contributing to this domain. Moral judgments progress along a continuum from pre-conventional to post-conventional thinking levels, with age and educational trajectories influencing these levels [25].

Conceptually, role-taking and empathy serve as prerequisites for moral sensitivity. Empathy evolves across five levels, from the infant's spontaneous cry to experiencing empathic distress beyond immediate circumstances. Strong positive correlations have been observed between role-taking and empathic concern, as well as between role-taking and moral reasoning. Research indicates linear age-related advancements in role-taking from adolescence to early adulthood, paralleled by the development of social moral judgment. Moreover, there is compelling evidence suggesting that exposure to diverse social experiences, such as interactions across age groups, socioeconomic strata, educational backgrounds, and engaging in role-taking activities with peers, fosters the development of moral judgment [25].

In the realm of gender's influence on moral performance, findings have been contradictory. While some argue that women exhibit higher moral standards than men, other studies suggest that men demonstrate superior moral reasoning. Meta-analyses, however, indicate no significant differences between men and women regarding moral decision-making abilities. Both genders can exhibit flawed reasoning, leading to erroneous judgments and hindering the pursuit of justice. By distinguishing between "sex," referring to biological characteristics, and "gender," about psychosocial attributes, research suggests that moral reasoning outcomes may vary between men and women. Studies have demonstrated a significant relationship between gender and cognitive moral development, with femininity scores playing a crucial predictive role. Interestingly, heightened femininity has been associated with lower scores in models explaining changes in moral-cognitive development [28]. Therefore, the findings of our study, which revealed no discrepancy between male and female professionals, are consistent, as the comparison was based on the biological sex of physiotherapists.

The present study's findings revealed no significant disparity in the level of awareness of professional ethics codes between employees in the private and public sectors. A review study identified 25 ethical issues pertinent to the employment sector, categorized into three primary domains: 1) business and economic concerns, such as conflicts of interest and disparities in managed care impacting the quality of care; 2) professional considerations, including professional independence, clinical judgment, treatment efficacy, and professional conduct; and 3) issues relating to patient's rights and well-being, such as confidentiality, power differentials, the balance between paternalism and patient autonomy, and informed consent [29]. These findings suggest that awareness and knowledge of professional ethics codes do not necessarily guarantee ethical conduct.

Notably, the current study solely assessed the awareness level of physiotherapists without insight into their professional practices. Another limitation of the study was that not all physiotherapists in Shiraz participated in this study.

Conclusion

In summary, the study suggests that Shiraz physiotherapists exhibit a commendable level of awareness regarding professional ethics codes, albeit certain areas may necessitate further training. Gender and the employment sector seem to exert no discernible influence on awareness levels. However, a notable correlation emerged between greater clinical experience and heightened familiarity with professilonal ethics codes among physiotherapists.

Acknowledgment

The authors thank K. Shashok (AuthorAID in the

Eastern Mediterranean) for improving the English in the manuscript and the Rehabilitation Research Center (Department of Physical Therapy, School of Rehabilitation Sciences) and Shiraz University of Medical Sciences for their support.

Conflict of Interest: None declared.

References

1. Gabard DL, Martin MW. Physical therapy ethics: FA Davis; 2010. https://books.google.com/books?id=aqqISAAACAAJ
2. Olejarczyk JP, Young M. Patient rights and ethics. StatPearls Publishing; 2021. https://www.ncbi.nlm.nih.gov/books/NBK538279/
3. Sabzevari A, Kiani MA, Saeidi M, Jafari SA, Kianifar H, Ahanchian H, et al. Evaluation of patients' rights observance according to patients' rights charter in educational hospitals affiliated to Mashhad University of medical sciences: medical staffs' views. Electron Physician. 2016; 8(10):3102-9.
4. Woogara J. Patients' rights to privacy and dignity in the NHS. Nurs Stand. 2005; 19(18):33.
5. MESH terms: Ethics, Professional. https://www.ncbi.nlm.nih.gov/mesh/68004995
6. Edwards I, Delany CM, Townsend AF, Swisher LL. New perspectives on the theory of justice: implications for physical therapy ethics and clinical practice. Phys Ther. 2011; 91(11):1642-52.
7. Code of Ethics for the Physical Therapist. https://www.apta.org/apta-and-you/leadership-and-governance/policies/code-of-ethics-for-the-physical-therapist
8. The Physiotherapy Board of Australia. Code of conduct for registered health practitioners. https://www.physiotherapyboard.gov.au/codes-guidelines/code-of-conduct.aspx
9. The World Confederation for Physical Therapy (WCPT). WCPT declaration of principle on ethical principles. https://world.physio/sites/default/files/2020-04/PS-2019-Ethical-principles.pdf
10. Mohamadi M, Rojhani-Shirazi Z, Enjoo SA, Shamsi-Gooshki E, Abdollahi I, Fatemeh Bahmani FB, et al. Proposing a set of ethical guidelines for Iranian physiotherapists: results of a modified Delphi technique. Indian J Med Ethics. 2022; VII (1):1-22.
11. Rose SJ. Editor's note: Gathering storms. Phys Ther. 1989; 69(5):354-5. https://doi.org/10.1093/ptj/69.5.354
12. Rose SJ. Editor's note: Our body of knowledge revisited. Phys Ther. 1989; 69(4):297-8. https://doi.org/10.1093/ptj/69.4.297
13. Magistro CM. Clinical decision making in physical therapy: a practitioner's perspective. Phys Ther. 1989; 69(7):525-34.
14. Singleton MC. Independent practice--on the horns of a dilemma. A special communication. Phys Ther. 1987; 67(1):54-7.
15. Purtilo RB. Understanding ethical issues. The physical therapist as ethicist. Phys Ther. 1974; 54(3):239-43.
16. Purtilo RB. Ethics teaching in allied health fields. Hastings Cent Rep. 1978; 8(2):14-6.
17. Guccione AA. Ethical issues in physical therapy practice. A survey of physical therapists in New England. Phys Ther. 1980; 60(10):1264-72.
18. Cantu R. Physical therapists' perception of workplace ethics in an evolving health-care delivery environment: a cross-sectional survey. Physiother Theory Pract. 2019; 35(8):724-37.
19. Kulju K, Suhonen R, Puukka P, Tolvanen A, Leino-Kilpi H. Self-evaluated ethical competence of a practicing physiotherapist: a national study in Finland. BMC Med Ethics. 2020; 21(1):43.
20. Swisher LL, Hiller P. The revised APTA code of ethics for the physical therapist and standards of ethical conduct for the physical therapist assistant: theory, purpose, process, and significance. Phys Ther. 2010; 90(5):803-24.
21. Gharibi F, Oskouei M, Tabrizi H, Jafarabadi M. Assessing the level of patient rights compliance in the physiotherapy clinic of Tabriz University of Medical Sciences in 2009. Med Ethics. 2012; 6(19): 27-46. https://doi.org/10.22037/mej.v6i19.3560 [Persian]
22. Souri N, Nodehi Moghadam A, Mohammadi Shahbolaghi F. Iranian Physiotherapists' Perceptions of the Ethical Issues in Everyday Practice. Iranian Rehabil J. 2020; 18(2):125-136.
23. Praestegaard J, Gard G. The perceptions of Danish physiotherapists on the ethical issues related to the physiotherapist-patient relationship during the first session: a phenomenological approach. BMC Med Ethics. 2011; 12:21.
24. Marques-Sulé E, Arnal-Gómez A, Cortés-Amador S, de la Torre MI, Hernández D, Aguilar-Rodríguez M. Attitudes towards learning professional ethics in undergraduate physiotherapy students: A STROBE compliant cross-sectional study. Nurse Educ Today. 2021; 98:104771. https://doi.org/10.1016/j.nedt.2021.104771.
25. Myyrya L, Juujärvi S, Pesso K. Empathy, perspective taking and personal values as predictors of moral schemas. J Moral Educ. 2010; 39:2, 213-233.
26. Tiruneh MA, Ayele BT. Practice of code of ethics and associated factors among medical doctors in Addis Ababa, Ethiopia. PLoS ONE. 2018; 13(8): e0201020. https://doi.org/10.1371/journal.pone.0201020.
27. Das S, Kaur S. Professional ethics grow with teaching experience: a study of women teachers in higher education institutions of Punjab. Eur Acad Res. 2014; 2(4): 5904-22.
28. Kracher B, Marble R. The significance of gender in predicting the cognitive moral development of business practitioners using the sociomoral reflection objective measure. J Bus Ethics. 2008; 78:503-26.
29. Hudon A, Drolet MJ, Williams-Jones B. Ethical issues raised by private practice physiotherapy are more diverse than first meets the eye: Recommendations from a literature review. Physiother Can. 2015; 67(2); 124–132.

JRSR 11 (2024) 76-82

Journal of Rehabilitation Sciences and Research

Journal Home Page: jrsr.sums.ac.ir

Original Article

Exploring the Relationship Between Educational Theories and Occupational Therapy Studies: A Correlation Analysis of Kolb's Learning Steps, Learning Styles, and Dunn's Sensory Processing Patterns Among Iranian Occupational Therapy Students

Sahar Ghanbari[1*], PhD; Hossein Bayat[2], BSc; Somaye Kavousipor[1], PhD

[1]Department of Occupational Therapy, School of Rehabilitation Sciences, Shiraz University of Medical Sciences, Shiraz, Iran
[2]Department of Speech and Language Pathology, School of Rehabilitation Sciences, Shiraz University of Medical Sciences, Shiraz, Iran

ARTICLE INFO

Article History:
Received: 22/01/2023
Revised: 09/06/2023
Accepted: 24/06/2023

Keywords:
Education
Learning
Occupational therapy
Sensation
Students

Please cite this article as:
Ghanbari S, Bayat H, Kavousipor S. Exploring the Relationship Between Educational Theories and Occupational Therapy Studies: A Correlation Analysis of Kolb's Learning Steps, Learning Styles, and Dunn's Sensory Processing Patterns Among Iranian Occupational Therapy Students. JRSR. 2024;11(2):76-82. doi: 10.30476/JRSR.2023.97835.1346.

ABSTRACT

Background: Learning encompasses lasting alterations in behavior stemming from experience. The sensory system receives and interprets information gathered from individual experiences, priming it for integration with other neuro-psychological facets of learning. The processes and modalities of learning, juxtaposed with sensory processing, may or may not exhibit interrelation akin to gears within a learning clock mechanism. The objective is to explore the potential correlation between the stages and styles of learning outlined by Kolb and the sensory processing patterns delineated in Dunn's model.

Methods: This correlational study involved undergraduate Occupational Therapy students from the Rehabilitation Faculty at Shiraz University of Medical Sciences (SUMS) in Iran. In 2018, all students were invited to participate and were asked to complete two questionnaires: The Kolb Learning Styles Inventory and the Adolescent/Adult Sensory Profile. Out of 83 distributed questionnaires, responses from 62 participants were included in the analysis. The collected data underwent descriptive and analytical statistical analyses using SPSS23 software.

Results: Findings revealed no significant correlation between Kolb's Learning Steps and Learning Styles and Dunn's Sensory Processing Patterns among Iranian Occupational Therapy students ($P>0.05$). However, there was a correlation between low registration and preferred learning steps among female students ($P=0.003$).

Conclusion The findings suggest no correlation between learning steps and learning styles with sensory processing patterns overall. However, gender-based analysis indicates a potential correlation among participants exhibiting low registration sensory patterns.

Introduction

Learning is a relatively stable behavioral change based on individuals' experiences, beginning from early developmental stages [1] and continuing throughout life [2]. Within the Theory of Experiential Learning, Kolb emphasizes that experience is fundamental in knowledge development, suggesting that learning occurs through active engagement and exploration [3]. Kolb's experiential learning theory outlines different steps of learning, including concrete experience (engagement in activities or tasks), reflective observation (stepping back to reflect on the task), abstract conceptualization (drawing conclusions from experience based on previous knowledge or discussing theories with peers), and active experimentation (applying conclusions to new experiences). While these steps work together to create an educational experience,

*Corresponding author: Sahar Ghanbari, PhD; Department of Occupational Therapy, School of Rehabilitation Sciences, Shiraz University of Medical Sciences (SUMS), Shiraz, Iran. **Email:** saghanbari@yahoo.com

individuals may prefer certain aspects over others. For instance, some may rely heavily on concrete and reflective experiences, whereas others may allocate less time to the active and abstract steps [3, 4].

Additionally, Kolb identified four different learning styles in his theory, namely diverging (concrete experience/reflective observation), assimilation (abstract conceptualization/reflective observation), converging (abstract conceptualization/active experimentation), and accommodating (concrete experience/active experimentation) [5]. Learning styles are viewed from various perspectives, including models of personality traits, information processing, social interaction, and instructional preference [6]. Furthermore, the learning process varies across different contexts, and learners do not all learn at the same rate or in the same manner. Individuals may respond differently in identical situations, influenced by their distinct learning styles. People adopt various learning styles based on their differences [7].

Based on the term "experience" in the defined learning process, knowledge acquisition relies on our sensory system to absorb information from the surrounding environment. The sensory system receives and processes this information, preparing it for other neuro-psychological aspects of learning systems [8] while influencing mood, emotions, and personal interests [9-14]. Research indicates that sensory processing may be the fundamental psychological element underlying perception and response to environmental stimuli [15]. As individuals' sensory processing patterns can influence their behavior in life [16], they are likely also to impact how they learn from their experiences, particularly in academic settings. This aspect warrants further exploration through related studies [17]. Recognizing the significance of this matter, Dunn highlighted that human beings live sensationally [16].

Dunn's sensory processing model explores how individuals perceive, regulate, interpret, and respond to sensory stimuli daily. Dunn developed the Four Quadrant Model of Sensory Processing, which posits a relationship between neurological thresholds and behavioral responses. A low neurological threshold indicates that an individual readily attends to and responds to stimuli. In contrast, a high neurological threshold suggests a need for more intense stimuli to elicit a response. When individuals attempt to self-regulate in response to a sensory experience, they may employ active or passive behavioral strategies. Within this model, there are four sensory processing patterns: sensory seeking (high neurological threshold, active responses), low registration (high neurological threshold, passive responses), sensory avoiding (low neurological threshold, active responses), and sensory sensitivity (low neurological threshold, passive responses).

A fundamental tenet of Dunn's Four Quadrant Model of Sensory Processing is that an appropriate balance between habituation and sensitization is necessary for effective sensory modulation and adaptive behavioral responses. For instance, individuals with sensory sensitivity often exhibit heightened focus on sensory experiences from their bodies and surroundings, leading to a sustained state of hyper arousal, hypervigilance, and emotional dysregulation. An individual may be described as sensory defensive when their nervous system is rapidly triggered, perceiving sensory stimuli as threatening or harmful, eliciting fight-or-flight responses in the sympathetic nervous system [18].

While most individuals experience a typical range of sensory processing, there may be variations, particularly in sensory sensitivity, even within a normal population [19]. Furthermore, learning styles (LS), preferences for learning, and sensory processing (SP) are akin to gears in the learning mechanism, potentially interconnected but not necessarily so. Several studies have explored the relationship between Kolb's learning styles and Gardner's Multiple Intelligence Theory [20, 21], as well as preferred learning styles among undergraduate students [22] and nursing students' Kolb learning styles and problem-solving skills [23]. While these studies suggest potential correlations between learning styles and other factors, such as intelligence and problem-solving skills, they do not specifically address the relationship between sensory processing and Kolb-based learning styles. Thus, it remains unclear whether there is a direct relationship between sensory processing and Kolb-based learning styles based on the existing research literature.

Moreover, Occupational Therapy bachelor students undergo various theoretical, practical, and clinical courses, engaging in various activities and tasks throughout their 4-year education. The objective of the current study was to explore the potential correlation between Kolb's Learning Steps and Learning Styles with Dunn's Sensory Processing Patterns. The authors conducted a correlational study involving Occupational Therapy students at Shiraz University of Medical Sciences (SUMS)

Based on the important issues outlined, the main questions addressed in this study were as follows:

1. What were the predominant sensory processing patterns among Occupational Therapy students?
2. Which learning steps were more and less prevalent among Occupational Therapy students?
3. What were the preferred learning styles among Occupational Therapy students?
4. Is there a correlation between learning styles and sensory processing patterns among Occupational Therapy students?
5. Is there a correlation between learning steps and sensory processing patterns among Occupational Therapy students?

Methods

This descriptive correlational study was conducted at Shiraz University of Medical Sciences in Iran in 2018. The study employed a census sampling method, which included all undergraduate Occupational Therapy students from the School of Rehabilitation Sciences at SUMS who were enrolled in 2018 and agreed to participate by completing an informed consent form. Incomplete questionnaires were excluded from the analysis. After obtaining participants' approval, printed

questionnaires were administered in face-to-face sessions at a quiet location within the rehabilitation faculty to ensure maximum concentration. Notably, participation in the study was voluntary for all students in the Occupational Therapy department. Each participant completed two questionnaires: first, the Kolb Learning Styles Inventory (KLSI-V3.1-2005), which was validated and deemed reliable by Ghasemi et al., consisting of 12 questions based on a forced Likert scale (totally matched, partly matched, matched a little, doesn't match) [24]. According to Kolb's theory, this questionnaire assessed four learning styles: Diverging, Assimilating, Converging, and Accommodating. The questionnaire also evaluated four learning steps: Concrete Experience, Reflective Observation, Abstract Conceptualization, and Active Experimentation.

Secondly, the Adolescent/Adult Sensory Profile (AASP) is a widely used and validated self-report measure of sensory processing in Occupational Therapy literature. It is known for its robust psychometric properties. The AASP assesses an individual's sensory processing and behavioral responses based on the Four Quadrant Model of Sensory Processing [25]. This questionnaire comprises four scales that gauge sensory seeking, sensory avoidance, sensory sensitivity, and poor registration across various sensory dimensions, including auditory, visual, movement, tactile, smell, and activity levels. Responses are scored on a five-point Likert scale, ranging from "almost never" (score 1) to "almost always" (score 5), with intermediate options for varying frequencies. In cases where a subject marks two answers on the answer sheet, the more dominant response, garnering more points, is considered. Each sensory processing pattern encompasses 15 questions, with the total score for each pattern derived from the cumulative scores of its related questions. Thus, the minimum score for each sensory processing style is 15, while the maximum is 75 [15]. Zaree et al. conducted the translation, reliability, and validity assessment of the Persian version of the Adolescent/Adult Sensory Profile [26].

The descriptive analysis included reporting each variable's mean, standard deviation, and percentage. The authors employed a Pearson chi-square test to determine the correlation between each factor of learning steps and learning styles with sensory processing patterns. Statistical analysis was conducted using IBM SPSS Statistics for Windows version 23.0, and P values below 0.05 were considered statistically significant.

Ethical Approval

The SUMS Research and Ethical Committee approved the study protocol with registration code IR.SUMS.REC.1397.531. Before participating in the study, written consent was obtained from each participant. They were assured of anonymity and guaranteed that their data would be used solely for research purposes, with no potential for it to be used either for or against them, and that no data manipulation would occur.

Results

Out of the total number of filled questionnaires (83), 21 were excluded due to incomplete responses, resulting in 62 questionnaires included in the analysis. Among the participants, 48 were female (77.4%) and 14 were male (22.6%). The mean age of the participants was 21±1.22. Regarding achievement scores, 12 participants (19.4%) received a score of A- up to A+ (17-20), 42 participants (67.7%) received a score of B- to B+ (14-16.99), and 8 participants (12.9%) received a score of C- to C+ (scores under 14). Furthermore, a statistically significant difference was observed between males and females in achievement scores, with females obtaining higher grades (P=0.03).

According to the results of learning steps, five individuals (8.1%) fell into the category of "concrete experience or feeling", 7 (11.3%) were categorized as "reflective observation or watching", 28 (45.2%) were classified under "abstract conceptualization or thinking", and 22 individuals (35.5%) were grouped as "active experimentation or doing".

According to the investigation of "learning styles" in the Occupational Therapy students, four individuals (6.5%) were classified as "diverging or feel and watch". In comparison, 14 individuals (22.6%) fell into the "assimilation or think and watch" category. Moreover, 36 individuals (58.1%) were categorized as "converging or think and do", and eight individuals (12.9%) were grouped as "accommodating or feel and do".

Table 1 reveals the participants' sensory processing patterns according to Adolescent/Adult Sensory Profile (AASP). Table 2 presents the correlation results for the following pairs: 'Low Registration and Learning Steps', 'Sensory Seeking and Learning Steps', 'Sensory Sensitivity and Learning Steps', 'Sensory Avoiding and Learning Steps', 'Low Registration and Learning Styles', 'Sensory Seeking and Learning Styles', 'Sensory Sensitivity and Learning Styles', and 'Sensory Avoiding and Learning Styles'. Table 3 displays the correlation P value results, segmented by gender.

A separate correlation test assessed gender differences between male and female groups. The results revealed a non-significant correlation between three sensory processing patterns (sensory seeking, sensory sensitivity, and sensory avoiding) and learning styles and learning steps in both groups. However, a strong correlation between Learning Steps and Low Registration was observed in the female group (P=0.003) (Table 3).

Table 1: Participants` sensory processing patterns according to Adolescent/Adult Sensory Profile (AASP)

Quadrants of Sensory Processing	Much less than most people	Less than most people	Similar to most people	More than most people	Much more than most people
Low Registration	0 [0%]	5 [8.1%]	33 [53.2%]	20 [32.3%]	4 [6.5%]
Sensory Seeking	1 [1.6%]	4 [6.5%]	49 [79%]	6 [9.7%]	2 [3.2%]
Sensory Sensitivity	0 [0%]	4 [6.5%]	37 [59.7%]	14 [22.6%]	7 [11.3%]
Sensory Avoiding	1 [1.6%]	4 [6.5%]	37 [59.7%]	14 [22.6%]	6 [9.7%]

Table 2: Correlation P value results of "Low Registration and Learning Steps", "Sensory Seeking and Learning Steps", "Sensory Sensitivity and Learning Steps", "Sensory Avoiding and Learning Steps", "Low Registration and Learning Styles", "Sensory Seeking and Learning Styles", "Sensory Sensitivity and Learning Styles", "Sensory Avoiding and Learning Styles"

Variables` correlation	Correlation P value
Low Registration and Learning Steps	0.104
Sensory Seeking and Learning Steps	0.778
Sensory Sensitivity and Learning Steps	0.615
Sensory Avoiding and Learning Steps	0.687
Low Registration and Learning Styles	0.680
Sensory Seeking and Learning Styles	0.788
Sensory Sensitivity and Learning Styles	0.654
Sensory Avoiding and Learning Styles	0.964

Table 3: Correlation P value results according to gender

Variables correlation	Female	Male	Overall
Low Registration and Learning Styles	0.13	0.51	0.68
Low Registration and Learning Steps	0.003 *	0.75	0.1
Sensory Seeking and Learning Styles	0.85	0.43	0.78
Sensory Seeking and Learning Steps	0.82	0.4	0.77
Sensory Sensitivity and Learning Styles	0.92	0.32	0.65
Sensory Sensitivity and Learning Steps	0.46	0.34	0.61
Sensory Avoiding and Learning Styles	0.86	0.21	0.96
Sensory Avoiding and Learning Steps	0.73	0.22	0.68

Discussion

The present study addressed various inquiries concerning learning steps, learning styles, and sensory processing patterns, along with their potential correlations among Occupational Therapy students enrolled at the School of Rehabilitation Sciences at SUMS in Iran.

The first question addressed in this study was: "What were the predominant sensory processing patterns among Occupational Therapy students?" The findings indicated that 53.2% of students fell within the normal range, while 46.8% exhibited patterns outside the normal range regarding low registration. Furthermore, 79% of participants demonstrated sensory seeking within the normal range, while 21% displayed patterns outside the normal range. Additionally, 59.7% performed similarly to most people regarding sensory sensitivity and sensory avoiding patterns, while 40.3% exhibited some deviation. Among all sensory processing dysfunctions, those related to the "more than most people" group were most prevalent. Greater student deviation appears to be associated with the 'low registration' pattern. In the sensory-seeking quadrant, their behavior largely mirrors the general population's. In a study by Ben-Avi et al. (2012) involving 123 undergraduate students at Haifa University, 88 students (71.5%) were found to be within the normal range, while 35 individuals (28.5%) exhibited patterns outside the normal range in terms of sensory defensiveness.

Furthermore, 87 individuals (70.7%) fell within the normal range in the sensory avoidance quadrant, while 36 individuals (29.3%) were outside the normal range. Similarly, 95 individuals (77.2%) exhibited patterns within the normal range within the sensory-seeking quadrant, whereas 28 individuals (22.8%) were outside the normal range. In the low registration quadrant, 84 individuals (68.2%) were classified as normal, while 39 individuals (31.8%) displayed patterns outside the normal range [12]. Mahmoudi et al. (2020) reported that among 184 students from various fields of rehabilitation sciences at Shahid Beheshti and Iran University of Medical Sciences, 46.7% of occupational therapy students exhibited sensory seeking problems, 27.38% experienced low registration problems, 33.5% encountered sensory sensitivity issues, and 32.43% faced sensory avoidance challenges [15].

The second question examined was: " Which learning steps were more and less prevalent among Occupational Therapy students?" The findings revealed that the preferred learning steps were as follows: "abstract conceptualization or thinking" (45.2%), "active experimentation or doing" (35.5%), "reflective observation or watching" (11.3%), and "concrete experience or feeling" (8.1%). There is a lack of direct research addressing the learning steps of occupational therapy students according to "Kolb's experiential learning cycle" in the available literature.

A study explores using Kolb's reflective learning cycle to support students' capacity for clinical reasoning and better prepare them for clinical placement [27]. This study suggests that Kolb's experiential learning cycle can support students' learning and development, although it does not provide specific information about the learning steps of occupational therapy students. From this perspective, occupational therapy students who prefer the concrete experience stage may be more inclined towards hands-on learning and prefer to acquire knowledge through direct experience. Conversely, those who favor the reflective observation step may prefer reflective learning and tend to learn through observation and analysis. Similarly, students who lean towards the abstract conceptualization step may prefer theoretical learning, preferring to engage in conceptualization and analysis. Lastly, students who resonate with the active experimentation step may demonstrate a propensity for experimental learning and prefer learning through trial and error.

The third question investigated in this study was: " What were the preferred learning styles among Occupational Therapy students?" The findings revealed that OT students in Iran exhibited a preference for various learning styles, with "converging or think and do", "assimilation or think and watch", "accommodating or feel and do", and "diverging or feel and watch" being the most favored styles in descending order.

Convergers, among OT students, emphasize problem-solving as a key learning approach. They demonstrate an ability to formulate and implement plans in novel situations promptly. Unlike Divergers, who tend to shy away from interpersonal interactions and observations, Convergers seek specialized solutions.

Assimilators, on the other hand, prioritize critical thinking. They excel in assessing facts and evaluating experiences holistically. Typically, they derive satisfaction from comprehensive analyses and seeing projects through from inception to completion [28].

Research by French et al. (2007) indicated that occupational therapy students exhibited preferences in learning styles, with 'diverging' at 30.2%, 'converging' at 28.4%, 'assimilating' at 22.4%, and 'accommodating' at 19.0% [6]. Similarly, Linares et al. (1999) observed that OT students could be categorized as "accommodators" or "convergers". Both groups demonstrate a propensity for active experimentation within the learning process, exhibiting tendencies towards either end of the concrete-abstract spectrum.

As "accommodators," students are inclined towards hands-on experiences and exhibit strengths in collaborative problem-solving. Conversely, "convergers" tend to favor abstract conceptualization, demonstrating proficiency in practical problem-solving tasks over social and interpersonal challenges [29].

Furthermore, Olivier et al. (2021) utilized the Grasha-Reichmann learning style inventory to evaluate the learning styles of OT and Physiotherapy (PT) students. They found a prevalent preference for the collaborative learning style among students (75%). Interestingly, male students exhibited higher scores in the competitive learning style than their female counterparts [30].

The fourth research question addressed in this study was: " Is there a correlation between learning styles and sensory processing patterns among Occupational Therapy students?" The study findings revealed no significant correlation between learning styles and sensory processing patterns in OT students.

Some previous studies offer insights into the potential relationship between learning styles and sensory processing patterns. For instance, a study explored the preferred learning styles among Diploma students of Occupational Therapy, revealing that the visual learning style was most favored, followed by active, sensing, reflective, and sequential styles [31]. In another investigation, two questionnaires were employed to explore the potential association between sensory learning style and rational learning style, suggesting a possible correlation [32]. However, it's worth noting that these correlations' strengths appear weak and not consistently aligned with expected directions.

Overall, these studies suggest that there may indeed be some correlations between learning styles and sensory processing patterns in Occupational Therapy students. However, it's important to note that the strengths of these correlations appear weak and inconsistent across different studies. Previous research has highlighted various factors that influence learning styles and sensory processing, indicating that examining only one factor related to each may present limitations.

Learning styles are a combination of beliefs, preferences, and behaviors individuals employ to facilitate learning in specific situations. These styles, like abilities, are somewhat shaped by an individual's interaction with their environment and can evolve over time. They are not static and can change depending on various factors such as the learning environment, individual characteristics, subject matter, level of knowledge, experience, and personal expectations. Thus, learning styles may be influenced by temporal factors, environmental conditions, and the evolving demands of life, highlighting the need to consider this dynamic nature in research investigations [33].

However, it is important to recognize that tailoring the introduction of learning styles to match learners' characteristics can enhance the learning process by personalizing the content based on individual preferences and characteristics [34]. Moreover, university education plays a crucial role in fostering abstract thinking skills and assisting students in addressing complex and relative issues. Therefore, there is a need for educational strategies that progressively transition from objective and experiential learning to abstract and intellectual learning. Each technological and media product in education serves as a unique means to convey knowledge [35].

The fifth research question addressed in our study was, "Is there a correlation between learning steps and sensory processing patterns among Occupational Therapy students?" The study findings revealed no significant correlations between these variables overall. However, an interesting observation emerged concerning female students, identifying a correlation between low registration and learning steps. This suggests that gender differences may have influenced the results of the current study on certain aspects.

Only one search result discusses both "sensory processing" and "learning steps" in the context of Kolb's experiential learning cycle. However, this source does not directly correlate these concepts. Instead, it presents a module that outlines the four stages of Kolb's learning cycle. According to this module, each stage contributes unique aspects to the learning experience. However, it does not explicitly mention any correlations between these stages and sensory processing patterns [36].

While one search result explored the connection between "learning steps" and "sensory processing" in the context of gender, it did not establish a direct correlation between the two. This study evaluated the learning styles of medical undergraduates and examined the gender-specific relationship between learning style and academic performance [22]. However, it found no statistically significant correlation between gender and learning styles. Other search results shed light on the relationship

between learning styles and sensory processing patterns but did not address gender-specific differences. For instance, one study investigated the potential association between sensory learning style and rational learning style and identified a potential correlation [32]. Although no direct correlation exists between learning steps and sensory processing patterns concerning gender, these studies underscore the significance of considering sensory processing patterns and learning styles in occupational therapy education.

Given our census sampling approach, it's essential to acknowledge that this study had limitations, such as including all students without considering their psychological and psychiatric backgrounds. Previous research shows these factors could potentially influence sensory processing patterns. Therefore, future studies should aim to address this limitation by incorporating larger sample sizes and considering participants' psychological and psychiatric backgrounds, particularly with attention to gender differences.

Conclusion

Based on the findings, there is no correlation between learning steps, learning styles, and sensory processing patterns. However, there may be a correlation based on gender, particularly in low registration sensory patterns. Therefore, our study highlights the importance of conducting future research on this topic, with a specific focus on gender differences and considering the mental health conditions of participants.

Acknowledgment

The authors sincerely thank all Occupational Therapy students who generously participated in this study. Thanks to Batool Kabootari, Maryam Khodayar, and Zahra Shekari for their valuable collaboration. This study was registered under the code No. (97-01-06-17101) and was conducted as a project at SUMS.

Funding/support

The research deputy of SUMS funded this study.

Authors' Contribution

All authors contributed to the conceptualization and design of the study. SGh performed material preparation, data collection, and analysis. SGh, HB, and SK wrote the first draft of the manuscript, and all authors reviewed and approved the final manuscript.

Conflict of Interest: None declared.

References

1. James DK. Fetal learning: a critical review. ICD: An International J of Research and Practice. 2010;19(1):45-54.
2. Roosevelt E. You learn by living: Westminster John Knox Press; 1983.
3. Kolb DA. Experiential learning: Experience as the source of learning and development: FT press; 2014.
4. Shakeri F, Ghazanfarpour M, Malakoti N, Soleimani houni M, Rajabzadeh Z, Saadat S. Learning Styles of Medical Students: A Systematic Review. Med Edu Bulll. 2022;3(8):435-50.
5. Childs-Kean L, Edwards M, Smith MD. Use of learning style frameworks in health science education.AJPE. 2020;84(7).
6. French G, Cosgriff T, Brown T. Learning style preferences of Australian occupational therapy students. AUSOTJ. 2007;54:S58-S65.
7. Soltani N, Pashm Foroosh B, Khalili M. Comparative Study of Medical Students Learning Styles in AJA University of Medical Sciences. Paramedical Sciences and Military Health. 2017;11(4):30-4.
8. Kelley JL, Chapuis L, Davies WI, Collin SP. Sensory system responses to human-induced environmental change. Frontiers in Ecology and Evolution. 2018;6(article 95):1-15.
9. Austin KM. Training needs of paraprofessionals supporting students with autism spectrum disorders: Virginia Commonwealth University; 2013.
10. Lionetti F, Pastore M, Moscardino U, Nocentini A, Pluess K, Pluess M. Sensory processing sensitivity and its association with personality traits and affect: A meta-analysis. J of Research in Personality. 2019;81:138-52.
11. Serafini G, Gonda X, Canepa G, Pompili M, Rihmer Z, Amore M, et al. Extreme sensory processing patterns show a complex association with depression, and impulsivity, alexithymia, and hopelessness. JAD. 2017;210:249-57.
12. Ben-Avi N, Almagor M, Engel-Yeger B. Sensory processing difficulties and interpersonal relationships in adults: an exploratory study. Psychology. 2012;3(01):70.
13. Engel-Yeger B, Dunn W. The relationship between sensory processing difficulties and anxiety level of healthy adults. BJOT. 2011;74(5):210-6.
14. Khodabakhsh S. The relationship between sensory processing patterns and depression in adults. MOJPC. 2017;3(1):49-56.
15. Mahmoudi E, Mirzakhani N, Tabatabaee SM. Relationship between Sensory Processing Disorder and Quality of Sleep in Rehabilitation Students of Shahid Beheshti University of Medical Sciences and Iran University of Medical Sciences in 2019. The Scientific Journal of Rehabilitation Medicine. 2020;9(4):62-70.
16. Dunn W. Living sensationally: Understanding your senses: Jessica Kingsley Publishers; 2007.
17. Hong S. The Correlation of Sensory Processing Type, Learning Styles and Learning Strategies for University Students. KASI. 2018;16(3):11-21.
18. Ranford J, MacLean J, Alluri PR, Comeau O, Godena E, LaFrance WC, et al. Sensory Processing Difficulties in Functional Neurological Disorder: A Possible Predisposing Vulnerability? Psychosomatics. 2020;61(4):343-52.
19. McCurdy C, Patiño S, McMahon J, Hagen S. Adults with Sensory Defensiveness and Their Use of Coping Strategies (Occupational Therapy Graduate Capstone Projects. 41.) 2022.
20. Neo T-K, Sabbaghan S. The Relationship Between Gardner's Multiple Intelligence and Kolb's Learning Style. IJKSS. 2012; 3:52-9.
21. Neo T-K, Sabbaghan S. The Impact of the Relationship between Gardner's Multiple Intelligence and Kolb's Learning Style. Knowledge Discovery, Transfer, and Management in the Information Age: IGI Global; 2014. p. 175-85.
22. Chouhan N, Shan R, Gupta M, Rashid S, Manhas M. Evaluation of preferred learning styles among undergraduate students of government medical college, Jammu. NJPPP. 2023;13(3):574-7.
23. Şahan S, Yıldız A, Şahin S. Identification of the relationship between nursing students' kolb learning styles and problem-solving skills. APJNH. 2020;3(2):1-8.
24. Ghasemi N, Rabi'ei M, Kalantari N, Abdi H. Psychometric Propertics (Factor Structure, Reliability and Validity) of the Modified Kolb Learning Styles Inventory (KLSI-V3. 1-2005) in Iranian Students.ESMS. 2015;7(6):361-7.
25. Brown C, Tollefson N, Dunn W, Cromwell R, Filion D. The adult sensory profile: Measuring patterns of sensory processing.AJOT. 2001;55(1):75-82.
26. Zaree M, Hassani Mehraban A, Lajevardi L, Saneii S, Pashazadeh Azari Z, Mohammadian Rasnani F. Translation, reliability and validity of Persian version of Adolescent/Adult Sensory Profile in dementia. Applied Neuropsychology: Adult. 2021:1-7.
27. Lee HC, Flavell H, Parsons D, Parsons R, Falkmer T. Developing Agentic Learners for 21st Century Practice: A Pedagogic Approach in Occupational Therapy.ASAHP 2016;45(1):8-13.
28. Kurt S. Kolb's experiential learning theory & learning styles. Educational Technology https://educationaltechnology net/

kolbs-experiential-learning-theory-learning-styles. 2020.
29. Linares AZ. Learning styles of students and faculty in selected health care professions. SLACK Incorporated Thorofare, NJ; 1999. p. 407-14.
30. Olivier B, Jacobs L, Naidoo V, Pautz N, Smith R, Barnard-Ashton P, et al. Learning styles in Physiotherapy and Occupational Therapy students: an exploratory study. SAJOT. 2021;51(2):39-48.
31. Priya J, Paulraj V, Ali AR, Vetrayan J. Learning style preferences among diploma students of occupational therapy in University technology MARA (UiTM). MEJSR. 2013; 14:603-9.
32. Covaci M, editor Spearman Correlations between Model / Style of Learning Sensory (Perceptual) and Model / Style of Learning Rational (Information Processing)2017: RJPS, Hyperion University.
33. Farajollahi M, Najafi H, Nosrati Hashi K, Najafiyan S. Relationship between learning styles and academic achievement of university students. ESMS. 2013;6(2):83-8.
34. Labib AE, Canós JH, Penadés MC. On the way to learning style models integration: a Learner's Characteristics Ontology. Computers in Human Behavior. 2017; 73:433-45.
35. Hedayati N, Amini N, Zamani BE. Matching Level between Professors' Selected Media and Emotional-Perception Preferences of Students. ESMS. 2015;8(5):309-16.
36. Shoulders CW, Myers BE. Teachers' Use of Experiential Learning Stages in Agricultural Laboratories.JAE. 2013;54(3):100-15.

JRSR 11 (2024) 83-87

Journal of Rehabilitation Sciences and Research

Journal Home Page: jrsr.sums.ac.ir

Original Article

Gastrocnemius Kinesio Taping: A Strategy to Preserve Lower Limb Damping during Fatigue and Its Implications for Injury Prevention

Sahar Boozari[1], PhD; Mohammad Ali Sanjari[2], PhD; Ali Amiri[3*], PhD; Ismail Ebrahimi Takamjani[3], PhD

[1]Department of Physiotherapy, Faculty of Medical Sciences, Tarbiat Modares University, Tehran, Iran
[2]Biomechanics Laboratory, Rehabilitation Research Center and Department of Basic Rehabilitation Sciences, School of Rehabilitation Sciences, Iran University of Medical Sciences, Tehran, Iran
[3]Department of Physiotherapy and Iranian Center of Excellence in Physiotherapy, School of Rehabilitation Sciences, Iran University of Medical Sciences, Tehran, Iran

ARTICLE INFO

Article History:
Received: 04/03/2023
Revised: 13/07/2023
Accepted: 23/07/2023

Keywords:
Athletic performance
Countermovement jump
Exhaustion
Tape
Viscoelastic behavior

Please cite this article as:
Boozari S, Sanjari MA, Amiri A, Ebrahimi Takamjani I. Gastrocnemius Kinesio Taping: A Strategy to Preserve Lower Limb Damping during Fatigue and Its Implications for Injury Prevention. JRSR. 2024;11(2):83-87. doi: 10.30476/JRSR.2023.98219.1354.

ABSTRACT

Background: This study aimed to investigate the impact of Kinesio tape (KT) on the viscoelastic properties of the lower limb, specifically stiffness and damping, before and after a fatigue protocol. KT is a commonly used therapeutic intervention believed to prevent injury, yet the available evidence on its effectiveness remains limited.

Methods: In this pre-post study, fifty healthy participants underwent countermovement jumps before and after a fatigue protocol. The study assessed the body's viscoelastic behavior under two conditions: with and without Kinesio tape (KT) applied to the gastrocnemius muscle, in both fatiguing conditions.

Results: The findings revealed a notable reduction in lower limb damping among male participants after fatigue in the condition without tape. Conversely, in the condition with tape, there was no significant change in damping, indicating that KT may prevent the significant decrease in lower limb damping induced by fatigue.

Conclusion: The study offers evidence supporting the beneficial effects of KT in maintaining shock absorption capacity post-fatigue. These benefits may stem from KT's potential to enhance muscular activity and contraction force. Given that muscles act as primary shock absorbers, KT application could bolster their ability to dampen sudden impact forces post-exhaustion, potentially lowering the risk of impact-related injuries. These findings advocate for the use of KT as a preventive measure.

Introduction

Kinesio Tape (KT) is a commonly used therapeutic modality in physiotherapy and sports physiotherapy, renowned for its purported advantages in pain reduction, enhancing activity levels, and injury prevention [1]. Past studies have shown favorable outcomes associated with KT, such as increased range of motion, muscle activation, strength, power, and pain alleviation. Moreover, there is a suggestion that KT's benefits are particularly evident during challenging activities like multi-joint tasks or in situations of fatigue [2-9].

Fatigue is a physiological condition commonly encountered during both everyday activities and sports engagements, and it can have detrimental effects on biomechanical parameters, elevating the risk of injuries [10]. In our prior research, employing a mass-spring-damper modeling approach, we determined that fatigue can lead to heightened stiffness in both males and females, along with a reduction in the shock absorption capacity

*Corresponding author: Ali Amiri, PhD; Department of Physiotherapy and Iranian Center of Excellence in Physiotherapy, School of Rehabilitation Sciences, Madadkaran St, Shahnazari St, Madar Sq, Mirdamad Blvd, P.O. Box: 15875-4391, Tehran, Iran. **Email:** amiri.a@iums.ac.ir

of the lower limb, particularly notable in males [11]. Stiffness denotes resistance to deformation, while shock absorption capacity reflects the damping properties of the body. These parameters characterize the viscoelastic response of the body to external forces [12, 13].

Applied forces represent one of the primary causes of injuries in sports activities. Activities such as running and jumping, which are prevalent in various sports, subject the body to substantial ground impact forces [14-16]. Extensive research has delved into the alterations in viscoelastic behavior during jumping and running [13, 17, 18]. The viscoelastic response of the human body during functional and multi-joint tasks is influenced by the overall stiffness and damping properties of tendons, ligaments, muscles, and bones across the entire body or within specific segments (e.g., the leg). Biomechanical models are employed to quantify these properties [12, 13]. Previous studies have indicated that diverse factors, including exercises, variations in functional parameters, and fatigue, can impact the global viscoelastic behavior. Moreover, these alterations can affect performance and the likelihood of injury [13, 17, 18]. As noted earlier, we observed an elevation in stiffness in both genders and a reduction in damping of the lower limb, specifically in men [11]. Therefore, considering that changes in viscoelastic behavior can influence injury risk, identifying methods to mitigate these changes in the human body following fatigue could be advantageous.

Therefore, this study aimed to investigate the potential influence of KT on the viscoelastic alterations occurring in the lower limb as a result of fatigue. Based on the hypothesis that KT, as an elastic element, could interact with the body and modulate its viscoelastic behavior, we aimed to examine its effects on stiffness and damping. While some studies have explored the impact of KT on ankle and center of mass stiffness [19, 20], none have specifically addressed its effects on segmental stiffness or damping behavior. Thus, our study aimed to fill this gap by examining the effects of KT on lower limb stiffness and damping during a fatigue-inducing landing task using force data and a mass-spring-damper model. By investigating the potential preventive effects of KT on lower limb injuries, our study contributes to understanding how KT may mitigate viscoelastic changes induced by fatigue.

Materials and Methods

Design

This study employed a pre- and post-design to examine the effects of KT under two conditions: before and after inducing fatigue. The participants were divided into male and female groups, with each group subjected to two fatigue-inducing scenarios. In each fatigue condition, KT was either applied or not applied to the gastrocnemius muscle. The independent variables of the study included the fatigue condition (pre- and post-fatigue), KT application (with and without KT), and gender (male and female). The dependent variables assessed were stiffness and shock absorption capacity, determined through the analysis of force data.

Participants

The experimental data were sourced from a previous study [19]. A total of 50 healthy non-athlete individuals participated, comprising 26 females (mean age 28.15±3.67 years, mean body mass 56.74±6.73 kg, mean height 1.62±0.04 m) and 24 males (mean age 26.62±4.45 years, mean body mass 75.16±12.78 kg, mean height 1.80±0.07 m). Sample size determination was performed using G*power version 3.1.9.2 (α=0.05, β=0.2) [21]. Participants had no history of orthopedic, neurological, or rheumatologic conditions and had not undergone surgeries on the lower extremity or lumbar vertebral area. All participants were physically active, engaging in physical activity at least twice a week. Before participation, all participants provided informed consent. This study was registered with the Ethics Committee of the Iran University of Medical Sciences with the registration number IR.IUMS.REC.1394.9211342213 and the Iranian Registry of Clinical Trials under the code IRCT2016091928310N3.

Test Procedure

The participants underwent a single leg countermovement jump both before and after a fatigue protocol targeting the plantar flexor muscles. The fatigue protocol involved performing five sets of heel raises at the pace of a metronome set to 40 beeps per minute [22]. Each participant continued with each set until they were unable to maintain the metronome pace for five consecutive clicks or were unable to continue the task. The pre-fatigue condition was always conducted before the post-fatigue condition. Before and after the fatigue protocol, participants randomly executed countermovement jumps under two conditions: one with KT applied to the gastrocnemius muscle and the other without. Each condition was separated by a rest period of 20-30 minutes. A standard 2-inch Y-shaped KT (K-Active classic Tape, 5 m/2.5 cm, Nitto Denko, Japan) was applied to the stretched gastrocnemius muscle. To facilitate muscle activity, a skilled physiotherapist applied the KT with approximately 35% tension, extending from the muscle's origin to its insertion (Figure 1). The tape's length was customized for each participant, considering the individual length of their gastrocnemius

Figure 1: Kinesio taping was applied over the gastrocnemius muscle.

muscle before the tape's application, ensuring that the tape maintained approximately 35% tension, considered optimal for enhancing muscle function. Two KT anchors were released from tension [1].

The plantar flexor muscles were chosen to be fatigued and taped due to their crucial role in jumping and damping the impact forces that occur during landing [23, 24]. Additionally, taping of these muscles is commonly performed in sports activities.

Data Collection and Processing

We collected force data using a piezoelectric force plate (Kistler type 9260AA, Kistler Instrument Corporation, Winterthur, Switzerland) at a sampling frequency of 1000 Hz. Subsequently, the data underwent filtration using a second-order zero-lag Butterworth filter with a cut-off frequency of 40 Hz. Employing a mass-spring-damper model and the force data, we calculated the stiffness and damping of the lower limb under conditions both before and after inducing fatigue, with and without the utilization of KT. The model formula and calculation process have been previously described [11].

In summary, we employed a mass-spring-damper model with two degrees of freedom [13] to evaluate the stiffness and damping characteristics of the lower limb. This model allows us to quantitatively assess the viscoelastic properties of the lower limb by considering the collective contributions of ligaments, tendons, fascia, muscles, and bones [12, 13]. The model consisted of two masses representing the body, along with two springs for elastic characteristics and two dampers for the viscosity behavior of the body. The method used to determine the masses allowed us to assess the viscoelastic behavior across the entire body, encompassing both one lower limb and other anatomical regions [11, 25].

Statistical Analysis

The study examined the stiffness and damping characteristics during the landing phase of the countermovement jump, both before and after the fatigue protocol, under two conditions: with and without KT. Due to the non-normal distributions of all variables as determined by the Shapiro-Wilk test and their persistence even after log-transformation, non-parametric statistical tests were employed. The Wilcoxon signed-rank and Mann-Whitney U tests were conducted using the statistical software SPSS version 17 (SPSS Inc, Chicago, IL, USA) to analyze all relevant conditions involving fatigue and KT. An effect size of 0.1 was considered small, 0.3 medium, and 0.5 large [26]. P values less than 0.05 were considered statistically significant.

Results

Table 1 presents descriptive statistics for stiffness and damping, including median values and interquartile ranges.

Following analysis with the Wilcoxon signed-rank test, a notable reduction in lower limb damping was observed in men after fatigue in the without-tape condition (P=0.026, effect size=0.32) [11]. Conversely, in the with-tape condition, there was no significant change in lower limb damping (P=0.317), suggesting that KT application effectively mitigated the significant decrease in lower limb damping associated with fatigue. Table 2 provides detailed outcomes of the Wilcoxon signed-rank test.

Moreover, to bolster the statistical analysis, Mann-Whitney U tests were conducted to compare the various conditions between the two groups. The outcomes of these tests unveiled non-significant differences (P>0.05), suggesting that the observed effects were primarily associated with fatigue-induced alterations in lower limb damping and the protective influence of KT in men rather than disparities between the groups.

Discussion

In this study, our main objective was to examine how KT influences the global viscoelastic behavior by assessing changes in fatigue-induced stiffness and damping. In our previous research, we noted an increase in lower limb stiffness due to fatigue in both genders, with only men displaying a decrease in lower limb damping [11]. Here, we specifically delved into analyzing the

Table 1: Median (interquartile ranges) of the lower limb damping and stiffness in the before-and-after fatigue protocol for the conditions with and without Kinesio Tape (Kinesio Tape (KT) and No Kinesio Tape (NK), respectively)

Parameters	Group	Before Fatigue		After Fatigue	
		NK[a]	KT	NK[a]	KT
Damping ($kN.s.m^{-1}$)	Men	0.85 (0.35)	0.82 (0.47)	0.30 (0.60)	0.57 (0.69)
	Women	0.70 (0.34)	0.77 (0.29)	0.56 (0.70)	0.70 (0.68)
Stiffness ($kN.m^{-1}$)	Men	15.59 (81.79)	14.95 (64.08)	133.91 (177.66)	138.98 (168.66)
	Women	14.51 (27.33)	13.86 (12.82)	110.37 (137.58)	109.14 (153.09)

[a]These results have been reported previously [11].

Table 2: P-value (effect size) of Wilcoxon signed-rank test results in various fatiguing and taping situations

Parameters	Group	Before Fatigue-With and without tape	After Fatigue-With and without tape	Without tape-Before and After fatigue	With tape-Before and After fatigue
Damping ($kN.s.m^{-1}$)	Men	0.39 (0.12)	0.20 (0.18)	0.02* (0.32)	0.31 (0.14)
	Women	0.12 (0.21)	0.48 (0.09)	0.36 (0.12)	0.39 (0.11)
Stiffness ($kN.m^{-1}$)	Men	0.88 (0.02)	0.93 (0.01)	0.001* (0.48)	0.001* (0.47)
	Women	0.92 (0.01)	0.97 (<0.01)	0.001* (0.47)	0.001* (0.48)

*Statistically significant. [a]These results have been reported previously [11].

effect of KT on viscoelastic parameters under pre- and post-fatigue conditions. Given our earlier finding that fatigue significantly diminishes lower limb damping in the without-KT condition, the absence of a difference between pre-and post-fatigue situations with KT suggests that KT effectively mitigates the decline in lower limb damping associated with fatigue.

A significant finding from this study was the ability of KT to preserve lower limb damping. Given that impact loads are a major contributor to sports-related injuries [14, 16, 24], the decrease in damping observed in men after fatigue [11] could potentially increase their susceptibility to impact-related injuries. However, applying KT to the gastrocnemius muscle effectively counteracted the decline in damping post-fatigue. This preventive effect could be linked to increased blood flow or enhanced muscle activation induced by KT.

Our fatigue protocol specifically targeted the plantar flexor muscles, with KT applied to the gastrocnemius. We hypothesize that KT's potential to increase blood flow [1, 27] facilitated the clearance of accumulated lactic acid in the fatigued muscles. Additionally, KT may have facilitated muscle activity and contraction force, countering the impact of fatigue on muscle activation [2-4, 6-9]. Considering muscles' critical role as primary shock absorbers [28, 29], KT likely preserves muscular function in effectively dampening impact forces post-fatigue, thereby reducing the risk of impact-related injuries. This preventive effect of KT on fatigue aligns with previous literature where it prevented reductions in power, work, and moments following fatigue [7-9].

Our results indicated that KT did not influence the stiffness of the lower limb, consistent with previous findings showing no impact of KT on local ankle joint stiffness or center of mass stiffness [19, 20]. This suggests that KT may not alter stiffness. However, it's essential to consider that KT was applied over a single muscle or body segment in these studies. Applying KT to multiple muscle groups might yield different results. Additionally, this study only examined the acute effects of KT, and further research is needed to explore its long-term effects, as its elastic effects may diminish after a few days.

One of the key strengths of this study is the utilization of a two degree-of-freedom mass-spring-damper model within the fields of physiotherapy and sports. Previous studies in rehabilitation and sports have typically used simpler one-degree-of-freedom models with only two elements (mass and spring), limiting their ability to assess global stiffness related to the center of mass [17, 18]. In contrast, our study employed a more intricate model with three elements (mass, spring, and damper), allowing for a comprehensive investigation of viscoelastic behavior during functional and multi-joint activities. Despite the complexity of the calculations involved, these multi-degree-of-freedom models provide researchers with a more detailed understanding of viscoelastic behavior [12, 13].

To our knowledge, only one prior study has previously employed a mass-spring-damper model to examine viscoelastic behavior during landing in athletes after ACL reconstruction [30]. As for KT, which is widely used in physiotherapy and sports, previous studies have primarily focused on investigating its impact on stiffness, with one study examining local stiffness at the ankle level and another examining global stiffness related to the center of mass, using a simple mass-spring model that solely considers elastic behavior [19, 20]. In contrast, our study employed a model with more degrees of freedom, allowing us to examine the behavior of the lower limb comprehensively. This approach provided more detailed insights compared to solely assessing the behavior of the center of mass in a one-degree-of-freedom model. Moreover, by incorporating the damper element, we were able to explore the influence of KT on both stiffness and damping behavior. The utilization of this more intricate model facilitated our understanding of the shock absorption effect of KT, which holds significant implications for injury prevention.

Conclusion

In summary, this study demonstrates the beneficial effect of KT in preserving shock-absorption capacity and restoring damping behavior, indicating its potential as an effective preventive intervention. The findings suggest that KT can effectively dampen applied impacts and contribute to injury prevention. This damping effect of KT may be attributed to its interaction with the musculoskeletal system, including increased blood flow, enhanced muscular activity, and altered kinematics. These results have important implications for sports physiotherapists and sports medicine physicians, highlighting the potential of KT as a valuable tool in promoting musculoskeletal health and reducing the risk of impact-related injuries.

Acknowledgment

Special thanks to the Departments of Physiotherapy and Basic Rehabilitation Sciences at Iran University of Medical Sciences. This study was supported by Iran University of Medical Sciences.

Conflict of Interest: None declared.

References

1. Kase K, Wallis J, Kase T. Clinical therapeutic applications of the kinesio taping method. 3 ed. Albuquerque, NM: Kinesio IP LLC; 2013.
2. Huang C-Y, Hsieh T-H, Lu S-C, Su F-C. Effect of the Kinesio tape to muscle activity and vertical jump performance in healthy inactive people. Biomed Eng Online. 2011;10(1):1-11.
3. Konishi Y. Tactile stimulation with Kinesiology tape alleviates muscle weakness attributable to attenuation of Ia afferents. J Sci Med Sport. 2013;16(1):45-8.
4. Kuciel N, Sutkowska E, Cienska A, Markowska D, Wrzosek Z. Myoelectrical activity of muscles stabilizing the sacroiliac joints before and after the use of elastic tapes in women suffering from Pregnancy-related Pelvic Girdle Pain. Ginekol Pol. 2020;91(4):223-30.
5. Lu Z, Li X, Chen R, Guo C. Kinesio taping improves pain and function in patients with knee osteoarthritis: a meta-analysis of randomized controlled trials. Int J Surg. 2018;59:27-35.
6. Mostert-Wentzel K, Swart JJ, Masenyetse LJ, Sihlali BH, Cilliers R, Clarke L, et al. Effect of kinesio taping on explosive muscle power of gluteus maximus of male athletes. S Afr J Sports Med. 2012;24(3):75-80.

7. Szymura J, Maciejczyk M, Wiecek M, Maciejczyk G, Wiecha S, Ochalek K, et al. Effects of kinesio taping on anaerobic power recovery after eccentric exercise. Res Sports Med. 2016;24(3):242-53.
8. Trecroci A, Formenti D, Rossi A, Esposito F, Alberti G. Short-term delayed effects of kinesio taping on sprint cycling performance. J Strength Cond Res. 2019;33(5):1232-6.
9. Zhang S, Fu W, Pan J, Wang L, Xia R, Liu Y. Acute effects of Kinesio taping on muscle strength and fatigue in the forearm of tennis players. J Sci Med Sport. 2016;19(6):459-64.
10. Paillard T. Effects of general and local fatigue on postural control: a review. Neurosci Biobehav Rev. 2012;36(1):162-76.
11. Boozari S, Sanjari MA, Amiri A, Ebrahimi Takamjani I. Fatigue effects on the viscoelastic behavior of men and women in a landing task: a Mass–Spring–Damper modeling approach. Comput Methods Biomech Biomed Eng. 2020;23(10):564-70.
12. Latash ML, Zatsiorsky V. Biomechanics and motor control: defining central concepts. New York: Academic Press; 2015.
13. Nikooyan AA, Zadpoor AA. Mass–spring–damper modelling of the human body to study running and hopping–an overview. Proc Inst Mech Eng H J Eng Med. 2011;225(12):1121-35. doi: https://doi.org/10.1177/0954411911424210.
14. Bates NA, Ford KR, Myer GD, Hewett TE. Impact differences in ground reaction force and center of mass between the first and second landing phases of a drop vertical jump and their implications for injury risk assessment. J Biomech. 2013;46(7):1237-41.
15. De Bleecker C, Vermeulen S, De Blaiser C, Willems T, De Ridder R, Roosen P. Relationship between jump-landing kinematics and lower extremity overuse injuries in physically active populations: a systematic review and meta-analysis. Sports Med. 2020;50:1515-32.
16. Hreljac A. Impact and overuse injuries in runners. Med Sci Sports Exerc. 2004;36(5):845-9.
17. Brughelli M, Cronin J. A review of research on the mechanical stiffness in running and jumping: methodology and implications. Scand J Med Sci Spor. 2008;18(4):417-26.
18. Butler RJ, Crowell III HP, Davis IM. Lower extremity stiffness: implications for performance and injury. Clin Biomech. 2003;18(6):511-7.
19. Boozari S, Sanjari MA, Amiri A, Ebrahimi Takamjani I. Effect of gastrocnemius kinesio taping on countermovement jump performance and vertical stiffness following muscle fatigue. J Sport Rehabil. 2018;27(4):306-11.
20. Fayson SD, Needle AR, Kaminski TW. The effects of ankle Kinesio® taping on ankle stiffness and dynamic balance. Res Sports Med. 2013;21(3):204-16.
21. Faul F, Erdfelder E, Lang A-G, Buchner A. G* Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. Behav Res Methods. 2007;39(2):175-91.
22. Pinsault N, Vuillerme N. Differential postural effects of plantar–flexor muscle fatigue under normal, altered and improved vestibular and neck somatosensory conditions. Exp Brain Res. 2008;191:99-107.
23. BabiĀ J, LenarĀiĀ J. Vertical jump: biomechanical analysis and simulation study. In: AC dPF, editor. Humanoid Robots, New Developments. Vienna Austria: IntechOpen 2007. p. 551-66.
24. Decker MJ, Torry MR, Wyland DJ, Sterett WI, Steadman JR. Gender differences in lower extremity kinematics, kinetics and energy absorption during landing. Clin Biomech. 2003;18(7):662-9.
25. Özgüven HN, Berme N. An experimental and analytical study of impact forces during human jumping. J Biomech. 1988;21(12):1061-6.
26. Cohen J. Statistical power analysis for the behavioural sciences. Hillsdale, NJ: Laurence Erlbaum Associates. Inc; 1988.
27. Kataoka Y, Ichimaru A. Effect of kinesio taping and low-strength exercises on blood pressure and peripheral circulation 2005. Available from: http://www.kinesiotaping.com/images/kinesio-association/pdf/research/2005-10.pdf
28. Mizrahi J, Voloshin A, Russek D, Verbitski O, Isakov E. The influence of fatigue on EMG and impact acceleration in running. Basic Appl Myol. 1997;7:111-8.
29. Nigg B, Wakeling J. Impact forces and muscle tuning: a new paradigm. Exerc Sport Sci Rev. 2001;29(1):37-41.
30. Schneider DK, Gokeler A, Otten B, Ford KR, Hewett TE, Divine J, et al. A novel mass-spring-damper model analysis to identify landing deficits in athletes returning to sport after ACL reconstruction. J Strength Cond Res. 2017;31(9):2590-8.

JRSR 11 (2024) 88-93

Journal of Rehabilitation Sciences and Research

Journal Home Page: jrsr.sums.ac.ir

Original Article

The Effect of Combined Fibular Reposition and Facilitatory Fibularis Longus Taping on Balance in Patients with Chronic Ankle Instability: A Randomized Clinical Trial

Katayoon Rezaei[1,2], PhD; Shohreh Taghizadeh[1], PhD; Amir Nejati[1], MSc; Farahnaz Emami[1,2*], PhD

[1]Department of Physical Therapy, School of Rehabilitation Sciences, Shiraz University of Medical Sciences, Shiraz, Iran
[2]Rehabilitation Sciences Research Center, Shiraz University of Medical Sciences, Shiraz, Iran

ARTICLE INFO

Article History:
Received: 14/03/2023
Revised: 22/05/2023
Accepted: 20/06/2023

Keywords:
Ankle sprain
Fibular repositioning tape
Joint laxity
Kinesio tape
Postural balance

Please cite this article as:
Rezaei K, Taghizadeh S, Nejati A, Emami F. The Effect of Combined Fibular Reposition and Facilitatory Fibularis Longus Taping on Balance in Patients with Chronic Ankle Instability: A Randomized Clinical Trial. JRSR. 2024;11(2):88-93. doi: 10.30476/JRSR.2023.98366.1360.

ABSTRACT

Background: Ankle sprains are common musculoskeletal injuries in sports and physical activities, often leading to balance impairments. The research investigated the impact of combined fibular repositioning taping (FRT) and facilitatory fibularis longus taping on postural balance and proprioception of the ankle joint in individuals with Chronic Ankle Instability (CAI).

Methods: The double-blind randomized controlled trial was conducted at the Rehabilitation Sciences Research Center, Shiraz University of Medical Sciences (SUMS). A total of 40 patients aged between 18 and 50 were randomly allocated to either the intervention or placebo group. In the intervention group, participants received a combined FRT and facilitatory fibularis longus taping. In contrast, participants in the placebo group received an adhesive gauze from the medial malleolus to the midpoint of the tibia. Static and dynamic postural stability and stability limits were evaluated using the Biodex Balance SD system. Proprioception of the ankle joint was assessed using the active ankle joint repositioning test with a Biodex isokinetic dynamometer. Data within each group were compared before and immediately after taping and 48 hours after taping.

Results: The comparison of static postural stability before and immediately after the taping application revealed a significant decrease within groups (P=0.01). Additionally, there was a statistically significant difference between groups before and 48 hours after taping (P=0.002). A significant difference was observed between groups immediately after taping (P=0.03) for dynamic postural stability at the double leg stance position. In contrast, no significant difference was found between groups 48 hours after taping (P=0.05).

Conclusion: The results suggest that combined FRT and facilitatory fibularis longus taping could enhance static and dynamic postural stability in individuals with CAI.

Introduction

Ankle sprains are among the most common injuries in physical activities and sports [1], with lateral ligament involvement being predominant. About 30% of ankle sprains progress to Chronic Ankle Instability (CAI) [2, 3]. CAI symptoms include pain, episodes of instability, muscle weakness and fatigue, recurrent sprains, reduced function, impaired postural stability, and limited ankle range of motion [1, 4]. CAI is categorized into Mechanical Ankle Instability (MAI), characterized by structural changes and laxity, and Functional Ankle

*Corresponding author: Farahnaz Emami, PhD; Department of Physical Therapy, School of Rehabilitation Sciences, Shiraz University of Medical Sciences, Shiraz, Iran. **Email:** emamif@sums.ac.ir

Instability (FAI), associated with proprioception and neuromuscular control deficits [5]. In inversion ankle sprains, arthrokinematics restrictions are observed, potentially leading to anterior and inferior fibular shifting relative to the tibia. This fibular positional anomaly may contribute to pain, reduced mobility, and sensorimotor deficits [6]. Additionally, arthrogenic muscle inhibition in muscles like the soleus and peroneal group has been implicated in CAI [7].

CAI often leads to deficits in postural control. Damage to the lateral ankle ligaments can impede proprioceptive nerve fibers, impairing postural balance. Studies have consistently found that individuals with CAI exhibit greater mediolateral and anteroposterior center of pressure velocity compared to healthy individuals [8].

Various treatment modalities can enhance postural balance in individuals with CAI, including whole-body vibration (WBV), balance training, joint mobilization techniques, and peroneal functional electrical stimulation [9, 10]. Kinesio tape (KT) has emerged as a popular intervention for preventing musculoskeletal conditions and enhancing athletic performance [11]. Numerous studies have demonstrated its effectiveness in reducing pain, improving proprioception, repositioning subluxated joints, and optimizing ankle proprioceptive function [12]. KT possesses elastic properties similar to skin and is designed to support and stabilize muscles and joints without limiting the range of motion. KT is also air-permeable and water-resistant, allowing it to be worn for extended periods without frequent removal [13].

FRT is used clinically as an intervention following ankle sprain [14]. A previous study showed that FRT may improve postural control performance in athletes with and without CAI immediately after taping [15]. Also, Takahashi et al. found that FRT caused significant improvement in modified-Y-balance composite scores compared with traditional taping in participants with and without CAI [16]. Another study showed that adding KT positively affects muscle strength, increasing the peak torque of the evertors, compared to the strengthening program alone [17]. However, other studies suggested that FRT does not improve postural balance in these patients [18-21].

To the best of the author's knowledge, while the immediate effects of FRT on postural balance have been tested [15], there is currently no study investigating the prolonged effect of combined FRT and facilitatory fibularis longus taping on postural balance in individuals with CAI.

Materials and methods

Study Design

The double-blind randomized controlled trial was conducted between December 2018 and June 2019 at the Rehabilitation Sciences Research Center, Shiraz University of Medical Sciences (SUMS), Shiraz, Iran. The Ethics Committee of the Vice Chancellor for Research at Shiraz University of Medical Sciences approved the study protocol in accordance with the principles of the Declaration of Helsinki (IR.SUMS.REHAB.REC.1397-011). Additionally, this manuscript is registered on the IRAN randomized trial site (IRCT20180820040841N1)

Participants

With a significance level set at 0.05 and power at 80%, 40 patients aged between 18 and 50 years old, based on the findings of a previous pilot study related to balance variables, were enrolled in this study. Before participation, all eligible subjects signed an informed consent form approved by the Ethics Committee of SUMS. The inclusion criteria were based on the guidelines of the International Ankle Consortium [22]. The participants were randomly assigned to either the intervention group (n=20) or the placebo group (n=20) using block randomization (block size=4). The participants' assignments to these groups are outlined in the flow diagram (Table 1).

Subjects meeting the following criteria were included in the study: Unilateral CAI diagnosis; History of at least one ankle sprain episode within a year before the study, associated with pain, swelling, and impairment in at least one day of Activity of Daily Living (ADL); Self-report of ankle joint giving way, recurrent ankle sprain, or instability (at least two episodes in the last six months before the study); Cumberland Ankle Instability Tool (CAIT) score <24; Foot and Ankle Ability Measure (FAAM) ADL score <90%; and FAAM Sport score less than 80%.

Subjects were excluded if they reported a previous history of surgery on musculoskeletal structures in the lower extremities, Positive history of fractures in each of the lower limbs, Acute injury to non-involved lower extremity structures within the past three months leading to at least one day of interrupted ADL; Any neurological and myopathic disorders; Positive history of lumbar radiculopathy; Untreated severe ankle sprain; Severe skin irritation to tape application; Knee malalignment deformity; and Pregnancy. Table 1 presents demographic and clinical characteristics of participants.

Table 1: Demographic and clinical characteristics of participants

Groups Variables	Intervention group (n=20)	Placebo group (n=20)	P value
	Mean±SD	Mean±SD	
Age (y)	30.05±7.35	29.45±7.82	0.8
Weight (k)	73.88±7.67	68.98±12.39	0.14
Height(cm)	173.55±5.21	169.95±8.46	0.11
CAIT (0-30)	19.85±2.13	19.95±1.88	0.43
FAAM ADL (%)	82.32±4.44	84.04±4.36	0.18
FAAM Sport (%)	68.59±5.60	70.16±6.91	0.87

CAIT: Cumberland Ankle Instability Tool; FAAM: Foot and Ankle Ability Measure; ADL: Activities of Daily Living; *The significance level was considered P<0.05

Interventions

Taping Protocols

Before applying the tape, the skin was shaved and cleaned with alcohol. The participants were positioned supine with their ankles kept in a neutral position.

The intervention group received a combination FRT and facilitatory fibularis longus taping. Two strips (20×2.5 cm) of Athletic Tape (Euro Tape, Mueller, USA) were used for FRT. One strip was applied from the distal end of the lateral malleolus around the posterior lower leg (Figure 1a). A manual pain-free posterolateral superior glide was applied to the distal fibula and maintained. In contrast, the strip was applied to maintain a posteriorly directed position of the fibula. A second strip was applied similarly to reinforce the taping [14, 23].

For facilitatory fibularis longus taping, one strip of KT (KT Tape Pro Extreme) was applied to the fibularis longus muscle from origin to insertion with 15%-35% elasticity (Figure 1b) [14, 24].

Patients in the placebo group received one adhesive gauze from the medial malleolus to the midpoint of the tibia without any tension or manual mobilization of the fibula [24].

Assessments

Measurement of Static and Dynamic Stability

The Biodex Balance System (SD, Inc., New York, USA) assessed static and dynamic postural stability. The BBS is a reliable device for evaluating stability indices in both static and dynamic postural alignments [25]. It features a circular platform moving freely in the anterior-posterior and mediolateral axes. This tool allows for up to 20° of foot platform tilt and calculates the Medio Lateral Stability Index (MLSI), Anterior-Posterior Stability Index (APSI), and Overall Stability Index (OSI) [26]. The device offers 12 levels of dynamic stability, ranging from the most stable (level 12) to the most unstable (level 1) [27]. In line with a previous study [28], the dynamic postural test on the BBS at level 8 represented a low instability condition.

During the single-leg stance test, participants were instructed to stand barefoot on the BBS-locked platform in static and dynamic (level 8) situations. They were asked to place both hands on their iliac crest. The heel was positioned on the D12 surface grid system for the single-leg stance on the left foot while the foot was angled at 10°. Similarly, for the single-leg stance on the right foot, the heel was adjusted on D10 with the foot angled at 10°. Each participant performed three 20-second trials with a 10-second interval between trials, and the average of the three trials was used for data analysis.

Furthermore, we assessed static and dynamic postural stability in a bilateral leg stance. Per the BBS user's operation manual, participants were instructed to place their left heel on the D6 surface grid system and their right heel on the D16 surface grid system. The participants' feet were angled at 10°. The test was conducted with the affected leg. Three trials were conducted with eyes open, and the mean score was calculated. Before the evaluation, all participants underwent a five-minute training session to adapt to the device.

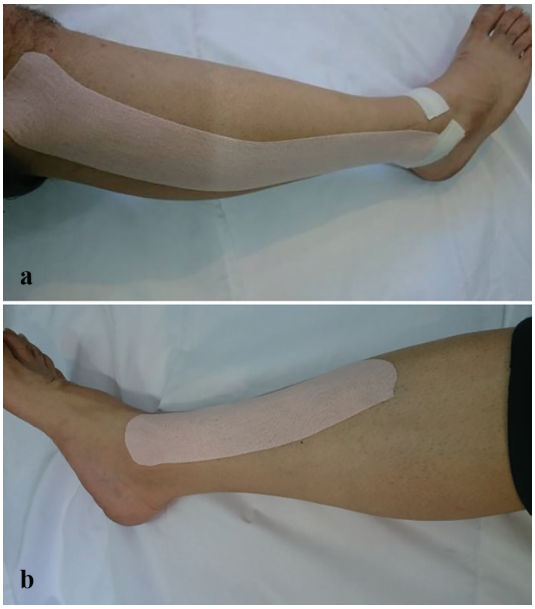

Figure 1: a. Combined fibular repositioning taping (FRT) and facilitatory fibularis longus taping, b. Facilitatory fibularis longus taping

Measurement of the Stability Limits

To measure the limit of stability (LOS), participants stood barefoot on the BBS sheet with both upper extremities comfortably at their sides. The LOS test default setting was considered to be 75% LOS. This test serves as a good indicator of dynamic postural control. Eight flashing circles appeared successively in random order on the screen. Participants were instructed to shift and control their center of gravity within their base of support (BOS). During each trial, participants shifted their weight and moved the cursor on the screen from the central circle to one peripheral flashing circle and back as quickly as possible. This process was repeated for each of the eight circles. Each trial ended when all eight blinking points had been reached. The test was repeated three times, with a 10-second interval between each repetition. All tests were performed with eyes open.

Ankle Joint Repositioning Assessment

The proprioception of the ankle joint was assessed using the active ankle joint repositioning test, conducted with the Biodex isokinetic dynamometer 4 pro. Each subject sits upright on the associated chair with the knee flexed to 75 degrees. This setup ensured proper placement of the patient's barefoot into the Biodex ankle inversion/eversion device, with the talocrural joint positioned in 15 degrees of plantar flexion. According to the manufacturer's instrumentation, the patient's foot was properly aligned with the axis of the isokinetic dynamometer. A small strap was placed around the proximal tibiofibular joint and the barefoot to provide stabilization. Subjects were blindfolded during the examination to eliminate visual feedback. Before the test, each subject underwent a practice session followed by a 30-second rest period. During the test, the foot was passively moved from the end range of maximal eversion to maximal inversion minus 5 degrees, where it was held for 10 seconds. Once in the test position, patients were

instructed to concentrate on the test angle. Subsequently, the foot was passively returned to the starting position, and the subjects were asked to reproduce the angle three times actively. The mean of three consecutive trials was recorded for analysis. Assessments of ankle joint repositioning were conducted before, immediately after, and 48 hours after taping. The assessor collected data, and the participants were blinded to group assignments throughout the evaluation process.

Statistical Analysis

Statistical analysis was conducted using SPSS software version 19 (IBM Statistics, New York, NY, USA). The normal distribution of the data was assessed using the Kolmogorov-Smirnov test. Nonparametric tests were employed since the data did not follow a normal distribution. Mann-Whitney U-tests were used to compare individual variables between groups. Additionally, an analysis of variance for repeated measures (ANOVA) was performed to assess the main effect of the tape intervention on postural balance. Post-hoc analyses were conducted as needed. Effect sizes were calculated using the eta-partial squared value. The significance level was set at $P<0.05$.

Results

The study included forty patients with CAI who met the inclusion criteria and were randomly assigned to either the intervention or placebo group, with twenty patients in each group. All participants completed the study as per protocol. No statistically significant differences were found between the groups in terms of age, weight, height, CAIT, FAAM ADL, and FAAM Sports scores ($P>0.05$) (Table 1).

Static Postural Stability (Bilateral Leg Stance)

In each group, static postural stability was assessed before, immediately after, and 48 hours after taping. The repeated measures ANOVA revealed a significant main effect of group ($F1,38=5.92$, $P<0.001$), a main effect of time ($F2,76=3.29$, $P=0.04$), and a significant interaction effect between time and group ($F2,76=3.87$, $P=0.02$) (Figure 2). Further analysis using the Mann-Whitney U test indicated a significant decrease in static postural stability between the groups before and immediately after taping application ($P=0.01$). Additionally, statistically significant differences were observed between the groups before and 48 hours after tapping ($P=0.002$).

Dynamic Postural Stability (Bilateral Leg Stance)

For dynamic postural stability, the analysis revealed significant main effects of group ($F1,38=3.53$, $P<0.001$) and time ($F2,76=3.26$, $P=0.04$), as well as a non-significant interaction effect between time and group ($F2,76=1.84$, $P=0.16$) (Figure 3). Further examination using the Mann-Whitney U test showed a significant difference between the groups for dynamic postural stability immediately after tapping ($P=0.03$). However, no significant difference was observed between the groups 48 hours after tapping ($P=0.05$).

Static Postural Stability (Single Leg)

For static postural stability, the analysis showed no statistically significant differences in the main effects of time ($F2,76=0.84$, $P=0.43$), group ($F1,38=0.51$, $P=0.47$), or the interaction effect between time and group ($F2,76=0.36$, $P=0.69$) (Figure 4).

Stability Limits

The results revealed a significant main effect of time ($F2,76=7.1$, $P=0.001$), indicating improvements in stability limits in the intervention group over time. However, no significant main effects were observed for the group ($F1,38=0.003$, $P=0.95$) or the interaction effect between time and group ($F2,76=0.03$, $P=0.97$) (Figure 5).

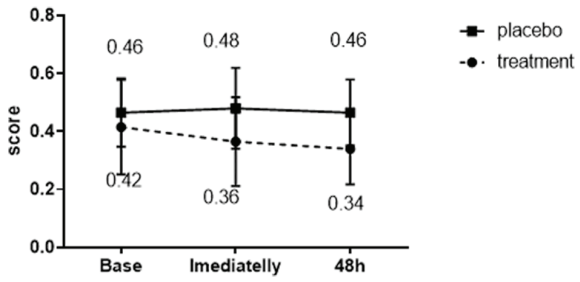

Figure 2: Changes in the mean score of double static postural stability

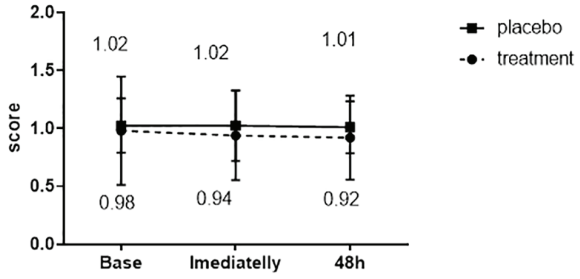

Figure 4: Changes in the mean score of single-leg static postural stability

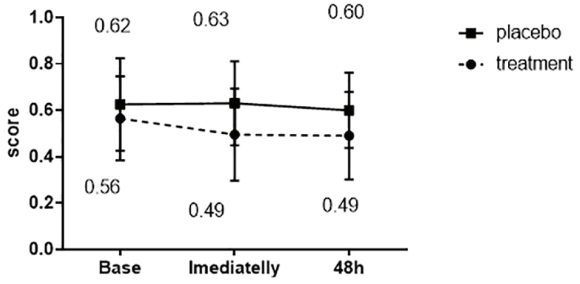

Figure 3: Changes in the mean score of double dynamic postural stability

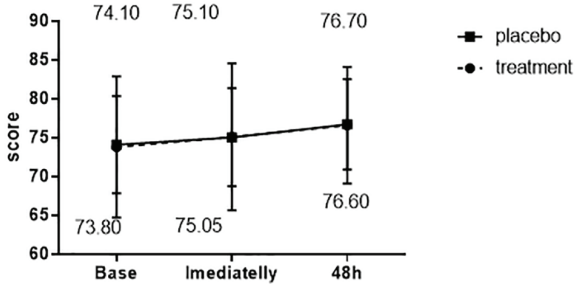

Figure 5: Changes in the mean score of stability limits

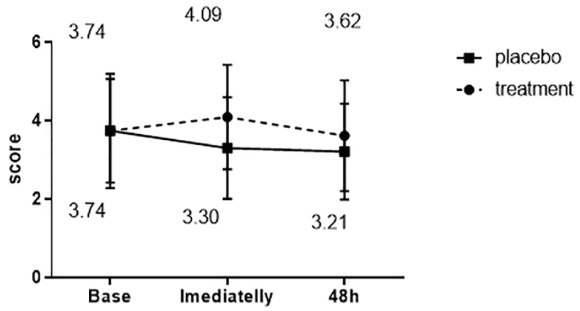

Figure 6: Changes in mean difference of ankle joint repositioning error

Ankle Joint Repositioning

According to the study results, there were no significant main effects for the group ($F_{1,38}=1.44$, $P=0.23$), time ($F_{2,76}=1.24$, $P=0.29$), or the interaction effect between time and group ($F_{2,76}=1.52$, $P=0.22$) (Figure 6).

Discussion

The current study aimed to assess the impact of combined FRT and facilitatory fibularis longus taping on postural performance immediately and 48 hours post-application in individuals with CAI. The findings revealed a significant effect over time, indicating an improvement in static postural stability during bilateral leg stance immediately and 48 hours after taping. The effect size for this improvement was large, with a value of 0.13. Additionally, the combined intervention enhanced dynamic postural stability during double stance immediately after application, albeit with a small effect size of 0.08, suggesting a relatively modest treatment effect.

The study findings indicate that the experimental group improved stability limits following the intervention. However, no significant differences were observed between groups immediately after and 48 hours post-application in stability limits values. To our knowledge, this study is the first to investigate the effects of the combined application of FRT and facilitatory fibularis longus taping. After an ankle sprain, mechanical stress is transmitted to the anterior tibiofibular ligament, resulting in the distal fibular bone being pulled anteriorly relative to the tibia, leading to a forward positional fault. This fibular positional abnormality can cause arthrokinematic restrictions, reducing the ability to achieve a full ankle dorsiflexion range. Restricted ankle dorsiflexion range has been shown to impact sensory-motor function and balance performance negatively [6, 29]. Altered arthrokinematics motions can increase ligamentous stress, and if not properly treated, recurrent ankle sprains may progress to CAI [29, 30].

The application of FRT involves positioning the fibular bone in a posterior-lateral direction. This technique is believed to increase mechanoreceptor inputs to the tissues, enhancing proprioception and improving balance ability [31]. Additionally, FRT may lead to improvements in movement directions, better postural control, and correction of positional faults of the distal fibula [32]. Previous research has shown that ankle plantarflexion-inversion range of motion and inversion-eversion tilt are reduced immediately after applying the tape. This, as depicted by Smith et al., suggests that FRT has both mechanical and psychological effects. After FRT application, participants often report increased perception of ankle joint stability, confidence, and reassurance during sports and other challenging tasks [33].

The findings of our study align with previous research that did not find significant enhancements in proprioception performance with the application of KT. For instance, Halseth et al. did not observe significant improvements in ankle reproduction of joint position sense (RJPS) during plantar flexion and plantar flexion with inversion motions [34]. Similarly, Simon et al. did not find significant differences in eversion force sense after KT application [35]. However, it is important to note that our results differ from those of Chang et al. and Seo et al., who reported improvements in proprioception performance following KT application [36, 37].

The mechanical stimulation induced by facilitatory fibularis longus taping enhances ankle stability by activating proprioceptors within the fibularis longus muscle, thereby improving proprioceptive feedback mechanisms and balance performance. When the tape is applied to the fibularis longus muscle, it increases the contact between the muscle and the skin, leading to heightened activity of sensory neurons that transmit signals to the spinal cord from cutaneous receptors.

This increased sensory input triggers a cascade of responses, including heightened activity of motor neurons and rapid excitatory firing of muscle spindles. Additionally, the stimulation of epidermal receptors elicits sustained muscle responses and provides crucial information about muscle contraction, ultimately contributing to improvements in static and dynamic balance [31].

In summary, the combined application of facilitatory fibularis longus taping and fibular repositioning taping promotes ankle stability, facilitates normal muscle activation, and enhances overall balance performance.

CAI often arises from recurrent lateral ankle sprains, leading to impaired mechanoreceptors in the lateral ligaments and disruptions in transmitting sensory information. This impairment manifests as deficient proprioception, decreased peroneal muscle strength, and reduced motor neuron excitability. Additionally, the healing process of injured ligaments can result in scar tissue formation, further destabilizing the ligaments and exacerbating neuromuscular control impairments that affect postural ability in individuals with CAI [38].

Previous studies have shown that patients with CAI typically exhibit characteristics such as a more inverted ankle position, reduced range of motion in dorsiflexion, and diminished activity in the peroneus longus muscle during quiet stance compared to healthy individuals. The peroneal muscles provide protective mechanisms and dynamic joint stability against lateral sprains [39].

The present study had several limitations that should be considered when interpreting the results. Firstly, the lack of a control group to investigate the potential placebo effects of KT is a notable limitation. Secondly, the follow-up period was limited to only 48 hours after taping the application. Future studies could benefit from

longer follow-up periods to assess the sustainability of the observed effects over time.

Conclusion

The comparison of static and dynamic postural stability between before and immediately after the application of tapping revealed a significant decrease between groups. Furthermore, the study results showed statistically significant differences between before and 48 hours after tapping between groups. These findings suggest that the combined application of FRT and facilitatory fibularis longus taping contributes to ankle stability, normal muscle activation, and improved balance performance over time.

Conflict of Interest: None declared.

References

1. Hertel J, Corbett RO. An updated model of chronic ankle instability. J. Athl. Train. 2019;54(6):572-88.
2. Halabchi F, Hassabi M. Acute ankle sprain in athletes: Clinical aspects and algorithmic approach. World J. Orthop. 2020;11(12):534-558.
3. Wang W, Liao D, Kang X, Zheng W, Xu W, Chen S, et al. Development of a valid Chinese version of the Cumberland Ankle Instability Tool in Chinese-speaking patients with chronic ankle instability disorders. Sci Rep. 2021;11(1):1-8.
4. Kobayashi T, Koshino Y, Miki T. Abnormalities of foot and ankle alignment in individuals with chronic ankle instability: a systematic review. BMC Musculoskelet Disord. 2021;22(1):1-8.
5. Fuerst P, Gollhofer A, Wenning M, Gehring D. People with chronic ankle instability benefit from brace application in highly dynamic change of direction movements. J Foot Ankle Res. 2021;14(1):1-11.
6. Weerasekara I, Osmotherly PG, Snodgrass S, Tessier J, Rivett DA. Is the fibula positioned anteriorly in weight-bearing in individuals with chronic ankle instability? A case control study. J Man Manip Ther. 2021;29(3):168-75.
7. Kim K-M, Ingersoll CD, Hertel J. Altered postural modulation of Hoffmann reflex in the soleus and fibularis longus associated with chronic ankle instability. J Electromyogr Kinesiol. 2012;22(6):997-1002.
8. De Ridder R, Willems T, Vanrenterghem J, Roosen P. Effect of tape on dynamic postural stability in subjects with chronic ankle instability. Int J Sports Med. 2015;36(04):321-6.
9. Jackson K, Simon JE, Docherty CL. Extended use of Kinesiology tape and balance in participants with chronic ankle instability. J Athl Train. 2016;51(1):16-21.
10. Gottlieb U, Hoffman JR, Springer S. The immediate carryover effects of peroneal functional electrical stimulation differ between people with and without chronic ankle Iistability. Sensors. 2022;22(4):1-12.
11. Hsiao C-K, Tsai Y-J, Lu C-W, Hsiung J-C, Hsiao H-Y, Chen Y-C, et al. Effects of kinesio taping on forearm supination/pronation performance fatigability. BMC Musculoskelet. Disord. 2022;23(1):1-10.
12. Kase K. Clinical Therapeutic Applications of the Kinesio Taping® Method. 2nd Edition Albuquerque. 2003.
13. Kim J-H, Cho M-R, Park J-H, Shin J-C, Cho J-H, Park G-C, et al. The effects of Kinesiotape on acute lateral ankle sprain: study protocol for a randomized controlled trial. Trials. 2018;19(1):1-10.
14. Moiler K, Hall T, Robinson K. The role of fibular tape in the prevention of ankle injury in basketball: A pilot study. JOSPT. 2006;36(9):661-8.
15. Someeh M, Norasteh AA, Daneshmandi H, Asadi A. Immediate effects of Mulligan's fibular repositioning taping on postural control in athletes with and without chronic ankle instability. PhysTher Sport. 2015;16(2):135-9.
16. Takahashi E, Chun Y, Kim J, Pettaway A, Baker R, Lee S, et al. Immediate effects of ankle tapes on dynamic postural control and kinematics in chronic ankle instability. Int J Exerc Sci: 2018; 50(5S):684-685.
17. Shea DC. Effect of Kinsio tape on stabilization and strengthening in people with chronic ankle sprains : 2018. [A dissertation].
18. Hopper D, Samsson K, Hulenik T, Ng C, Hall T, Robinson K. The influence of Mulligan ankle taping during balance performance in subjects with unilateral chronic ankle instability. PhysTher Sport. 2009;10(4):125-30.
19. Delahunt E, McGrath A, Doran N, Coughlan GF. Effect of taping on actual and perceived dynamic postural stability in persons with chronic ankle instability. Arch Phys Med Rehabil. 2010;91(9):1383-9.
20. Wheeler TJ, Basnett CR, Hanish MJ, Miriovsky DJ, Danielson EL, Barr J, et al. Fibular taping does not influence ankle dorsiflexion range of motion or balance measures in individuals with chronic ankle instability. J Sci Med Sport. 2013;16(6):488-92.
21. Hadadi M, Haghighat F, Sobhani S. Can fibular reposition taping improve balance performance in individuals with chronic ankle instability? A randomized controlled trial. Musculoskelet. Sci. Pract. 2020;46:1-5.
22. Gribble PA, Delahunt E, Bleakley C, Caulfield B, Docherty C, Fourchet F, et al. Selection criteria for patients with chronic ankle instability in controlled research: a position statement of the International Ankle Consortium. J Orthop Sports Phys Ther. 2013;43(8):585-91.
23. Chou E, Kim K-M, Baker AG, Hertel J, Hart JM. Lower leg neuromuscular changes following fibular reposition taping in individuals with chronic ankle instability. Man Ther.. 2013;18(4):316-20.
24. Kim MK, Shin YJ. Immediate effects of ankle balance taping with kinesiology tape for amateur soccer players with lateral ankle sprain: a randomized cross-over design. Medical science monitor: Int J Clin Exp. 2017;23:5534-5541.
25. Cachupe WJ, Shifflett B, Kahanov L, Wughalter EH. Reliability of biodex balance system measures. Meas Phys Educ Exer.2001;5(2):97-108.
26. Karimi N, Ebrahimi I, Kahrizi S, Torkaman G. Evaluation of postural balance using the biodex balance system in subjects with and without low back pain. Pak J Med Sci. 2008;24(3):372-7.
27. Chun W, Kim H-s, Park S, Park J, Shim S, Park S. The Influence of pronated foot posture on knee isokinetic strength, static and dynamic postural stability in healthy young individuals. Phys Ther Korea. 2021;28(3):168-76.
28. Khalili SM, Barati AH, Oliveira R, Nobari H. Effect of combined balance exercises and Kinesio taping on balance, postural stability, and severity of ankle instability in female athletes with functional ankle instability. Life. 2022;12(178):1-12.
29. Zettlemoyer A, Patterson R, Baker R, Nasypany A. Using the Mulligan Mobilization with Movement and fibular repositioning to treat high school patients with grade one lateral ankle sprain. Clinical Practice in Athletic Training. 2022;5(1):22-30.
30. Biz C, Nicoletti P, Tomasin M, Bragazzi NL, Di Rubbo G, Ruggieri P. Is kinesio taping effective for sport performance and ankle function of athletes with chronic ankle instability (CAI)? A systematic review and meta-analysis. Medicina. 2022;58(5):1-15.
31. Kim H-S, Park J-Y. Effect of muscle taping and joint taping on static and dynamic balance in normal adults with chronic ankle instability. J. Korean soc integr med. 2022;10(1):101-8.
32. Kulkarni N, Palekar TJ. The immediate effects of Mulligan Taping on pain and weight distribution in lateral ankle instability: A case study. Executive Editor. 2019;13(1):97-100.
33. Smith MD, Vitharana TN, Wallis GM, Vicenzino B. Response profile of fibular repositioning tape on ankle osteokinematics, arthrokinematics, perceived stability and confidence in chronic ankle instability. Musculoskelet Sci Pract.. 2020;50:102272.
34. Halseth T, McChesney JW, DeBeliso M, Vaughn R, Lien J. The effects of kinesio™ taping on proprioception at the ankle. J Sports Sci. Med. 2004;3(1):1-9.
35. Simon J, Garcia W, Docherty CL. The effect of kinesio tape on force sense in people with functional ankle instability. Clin J Sport Med. 2014;24(4):289-94.
36. Chang H-Y, Chou K-Y, Lin J-J, Lin C-F, Wang C-H. Immediate effect of forearm Kinesio taping on maximal grip strength and force sense in healthy collegiate athletes. Phys Ther Sport. 2010;11(4):122-7.
37. Seo H-D, Kim M-Y, Choi J-E, Lim G-H, Jung S-I, Park S-H, et al. Effects of kinesio taping on joint position sense of the ankle. J Phys Ther Sci. 2016;28(4):1158-60.
38. Yin L, Wang L. Acute effect of kinesiology taping on postural stability in individuals with unilateral chronic ankle instability. Front Physiol. 2020;11(192):1-8.
39. East MN, Blackburn JT, DiStefano LJ, Zinder SM, Norcross MF. Effects of fibular repositioning tape on ankle kinematics and muscle activity. Athl Train Sports Health Care. 2010;2(3):113-22.

JRSR 11 (2024) 94-101

Journal of Rehabilitation Sciences and Research

Journal Home Page: jrsr.sums.ac.ir

Original Article

Comparing the Applicability of Three Different Speech Therapy Service Delivery Models for Preschoolers with Intellectual Disability: A Single-Blind Randomized Controlled Trial

Mana (Monireh) Aminian[1], PhD Student; Mahnaz Karbalaei Sadegh[1], PhD; Masoomeh Salmani[2*], PhD; Hayat Ameri[3], PhD

[1]Department of Linguistics, Faculty of Literature, Humanities and Social Sciences, Science and Research Branch, Islamic Azad University, Tehran, Iran
[2]Neuromuscular Rehabilitation Research Center, Semnan University of Medical Sciences, Semnan, Iran
[3]Department of Linguistics, Faculty of Humanities, Tarbiat Modares University, Tehran, Iran

ARTICLE INFO

Article History:
Received: 25/02/2023
Revised: 07/06/2023
Accepted: 14/06/2023

Keywords:
Intellectual disability
Schools
School Health Services
Speech therapy
Students

Please cite this article as:
Aminian M, Karbalaei Sadegh M, Salmani M, Ameri H. Comparing the Applicability of Three Different Speech Therapy Service Delivery Models for Preschoolers with Intellectual Disability: A Single-Blind Randomized Controlled Trial. JRSR. 2024;11(2):94-101. doi: 10.30476/JRSR.2023.98183.1352.

ABSTRACT

Background: Many Speech and language pathologists (SLPs) are employed by Iran's Ministry of Education, with services traditionally delivered through a pull-out model. However, alternative service delivery models (SDMs), such as classroom-based and consultant approaches, are also available for SLPs working in schools. While the advantages of these approaches have been established in other countries, their effectiveness in the Iranian context remains unexplored. This study sought to determine which SDM is more effective in enhancing language skills among Persian-speaking children with intellectual disability (ID) in Iran.
Methods: This study employed a single-blind, randomized, controlled trial design. Twenty-one preschoolers, with a mental age of approximately 4:6, were randomly assigned to one of three groups (pull-out, classroom-based, and consultant) to receive speech therapy services. Language skills of all students were assessed by an experienced speech therapist using the Persian version of Test of Language Development-Persian:3 (TOLD-P:3), which has demonstrated favorable content validity and acceptable reliability. The language age of students on core subtests and their compositions were compared using the Kruskal-Wallis test.
Results: Analyzing language areas and compositions revealed that speech therapy was effective across all delivery service models. However, notable changes were observed in students under the consultant model, particularly in their "Grammatical completion" score (P=0.011). Additionally, significant improvements were noted in four other composition scores: 'spoken language' (P=0.05), 'organizing' (P=0.009), 'speaking' (P=0.017), and 'syntax' (P=0.055).
Conclusion: The findings of this study demonstrate that speech therapy, irrespective of the service delivery models (SDMs), effectively improves language skills in children with ID. However, the consultant model emerged as the most effective among the three models (pull-out, classroom-based, and consultant) for children with ID.

Introduction

The American Speech-Language-Hearing Association (ASHA) defines service delivery as a dynamic process encompassing four dimensions of providing speech and language pathologist (SLP) services: 1) Setting: This refers to the location where the intervention is delivered, such as home, clinic, school, pull-out, push-in, or within the classroom. 2) Dosage: This dimension includes the duration (length of intervention), frequency (number of intervention sessions during a specific period), and

*Corresponding author: Masoomeh Salmani, PhD; Neuromuscular Rehabilitation Research Center, Semnan University of Medical Sciences, Semnan, Iran. **Tel:** +98 9128310924; **Email:** salmani_masoome@yahoo.com

intensity (amount of time SLPs spend in each therapeutic session) of the intervention. 3) Format: Format pertains to how SLPs provide the intervention, whether one-on-one, in a group setting, or through consultation with school staff and.or family members. 4) Provider: This dimension involves identifying who administers the intervention, including SLPs, school staff, volunteers, parents, or trained personnel [1, 2].

ASHA has categorized speech and language therapy services into two main types: direct and consultative, marking a shift from the caseload to the workload model [1, 3]. Direct services involve interventions where SLPs have direct contact with their clients on a one-to-one basis or in a group setting. Consultative services, also known as indirect services, involve SLPs coaching and collaborating with teachers, guardians, caregivers, parents, or other individuals responsible for promoting the communication skills of the client [1].

ASHA identifies seven distinct ways to deliver speech and language services within school settings: Collaborative consultation, Monitoring, Language-based classroom, Combination, Pullout, Community-based, and Self-contained classroom [4]. Paul extensively discusses three models in her book: Pull-out, Consultant and Collaboration, and Language-Based Classroom. She provides detailed explanations of how these models dictate where, when, how, and with whom the intervention occurs, shedding light on the roles assumed by SLPs in school settings. These roles outline the objectives and goals that SLPs should pursue in their service delivery [5].

The roles undertaken by SLPs in schools encompass a range of responsibilities, including screening, assessment, intervention, consultation, resource allocation, activity design, monitoring, and termination of language, communication, and literacy intervention plans for students [6-10]. Currently, SLP services are an integral component of the rehabilitation process provided by special schools to children in Iran. The exceptional education sector in the country comprises 719 rehabilitation workers, with 386 SLPs catering to the needs of approximately 57,000 students with special needs. Among these students, those with physical disabilities, intellectual disabilities, multiple disabilities, and autism spectrum disorders receive the highest proportion of SLP services [11, 12].

Beyond children with disabilities, various studies conducted in Iran have highlighted the significant demand for SLP services among students in mainstream schools. For instance, a study conducted in Zanjan city revealed that 10.2% of 1,170 students exhibited various speech and language disorders [13]. Similarly, in Semnan City, 7.8% of 3,013 students were reported to have pronunciation disorders [14]. In Tehran, another study found that 16.1% of 1,010 elementary school students had speech and language disorders, while between 24% and 27% of children were diagnosed with learning disorders [15]. Additionally, in Arak, 11.9% of primary school students were identified as having speech disorders [16], and approximately 11% of 600 students in Kermanshah were reported to have speech disorders [17]. Despite the substantial need for SLP services in mainstream schools, it is surprising to note that these schools in Iran do not have any officially employed SLPs to address the needs of these children.

In 1986, in the United Kingdom, Enderby and Davies reported that approximately 26 qualified SLPs would be needed per 100,000 population [18]. The most recent report released by ASHA avoided reporting any specific figure as a 'good' SLP.population ratio. They mentioned that "population density, client demographics, service needs, and the presence of support staff" must be considered to calculate the SLP.population ratio [19]. From any perspective (the number of children with disabilities present at special needs schools or the percentages of children with communication disorders), currently, there are not enough employed SLPs to provide services in Iran's exceptional and mainstream schools.

The responsibilities of SLPs have evolved with the emergence of newer models, positioning them within schools and communities [6]. However, without increasing the number of employed SLPs or implementing policies to place SLPs in mainstream schools, the amount of time each client receives SLP services may decrease, or the number of clients receiving specialized SLP services may be limited. The size of SLPs' caseloads significantly influences the selection of service delivery models, and larger caseloads can impact collaboration levels with school staff and the provision of support to each student [20-22]. To address the shortage of employed SLPs, SLP services can be delivered through various pathways. Systematic reviews have not shown the superiority of one service delivery model over others; rather, they have confirmed the effectiveness of various speech therapy service delivery models in schools [8, 9, 23-25].

In summary, given the significant gaps in the evidence and the implications for clinical practice in schools [23], there is a pressing need for local and focused research to establish a substantial evidence base for Iranian SLPs, aiding them in selecting the most effective service delivery approach. Therefore, the present study aimed to investigate the linguistic outcomes in children with intellectual disability (ID) who received speech therapy services under specific SD models to provide SLPs with a broader array of options to deliver their services to a wider range of clients.

Methods

This paper constitutes the second part of a larger study to evaluate the effectiveness of various SLP service delivery models in Iran, encompassing diverse populations with and without language disorders.

Participants

The study population comprised all preschoolers with ID enrolled in exceptional schools in Semnan, Iran, during the 2022-2023 academic year. Students meeting the inclusion criteria were selected from three exceptional schools through purposive sampling. Inclusion criteria stipulated that children must have a mental age of at least 4, be deemed educable, be enrolled in preschool grade 2, exhibit no signs or symptoms of known syndromes, and

be of any gender. The sole exclusion criterion was lack of parental consent; any family declining participation would have their child excluded from the study while remaining in routine rehabilitation programs. Although all preschoolers registered for the 2021-2022 educational year were invited to participate, 12 were ultimately excluded, leaving 21 participants whose parents provided consent and who met all inclusion criteria.

This study was conducted by ethical guidelines and received approval from the Semnan University of Medical Sciences (ethics code=IR-SEMUMS-REC. 1401. 163) and was registered with the Iranian Registry of Clinical Trials (IRCT20180612040069N2). Informed consent was obtained from all participants, and families were assured that their children would not be harmed, their identities and information would remain confidential and anonymous throughout the study, and they could withdraw from the study at any time without consequences. The data collection process commenced only when families and children were ready to participate, and no costs were imposed on participants for evaluations or interventions. The initial 10 minutes of each evaluation session were dedicated to rapport building, and no students were compelled to participate in assessment sessions if they chose not to; in such cases, assessments were rescheduled for another day.

Service Delivery

Pullout services involve the SLP working with children individually or in small groups outside the classroom [4].

Classroom-based service delivery occurs when the SLP engages in whole-class instruction, small group sessions, or guided learning within the classroom setting. In this model, collaboration with the classroom teacher is key, with the SLP either teaching alongside the teacher or alternating teaching responsibilities [26].

Collaborative Consultation refers to a scenario where the SLP does not directly interact with the student but instead collaborates with teachers and families to support the student's communication needs [4].

Outcome Measurements

A comprehensive array of assessment tools was administered to evaluate various aspects of children's language abilities. However, only the outcomes of the adapted version of the Language Development Test (Newcomer and Hamill: TOLD-P: 3) and demographic information will be presented for brevity and to leverage the benefits of our standardized language test.

A comprehensive array of assessment tools was administered to evaluate various aspects of children's language abilities. However, only the outcomes of the adapted version of the Language Development Test (Newcomer and Hamill: TOLD-P: 3) and demographic information will be presented for brevity and to leverage the benefits of our standardized language test. The Test of Language Development-Persian:3 (TOLD-P:3), standardized for Persian-speaking children aged 4-11 [27], comprises six core subtests: *Picture vocabulary, Relational vocabulary, Oral vocabulary, Grammatical understanding, Sentence Imitation, and Grammatical Completion*. Additionally, the scores of the core subtests are aggregated in various formats to generate six composite scores representing the major dimensions of language [27]:

- Spoken Language: Picture Vocabulary, Relational Vocabulary, Oral Vocabulary, Grammatical Understanding, Sentence Imitation, and Grammatical Completion
- Listening: Picture Vocabulary and Grammatical Understanding
- Organizing: Relational Vocabulary and Sentence Imitation
- Speaking: Oral Vocabulary and Grammatical Completion
- Semantics: Picture Vocabulary, Relational Vocabulary, Oral Vocabulary
- Syntax: Grammatical Understanding, Sentence Imitation, and Grammatical Completion

The three supplemental subtests assess the prerequisites of literacy skills. Raw scores can be converted into age scores, standard scores, and percentile scores to compare each child with the appropriate age range.

Procedure

The present study utilized a single-blind controlled trial design. An expert panel comprising the head of speech and language therapists working at schools, the deputy manager of research at the Semnan Branch of the Ministry of Education, a biostatistician, and an academic team of SLPs from Semnan University of Medical Sciences, convened to discuss the applicability of various SLPs-SD. They reached a consensus on the suitability of the pull-out, collaborative consultation, and classroom-based models for implementation in this study.

Following the acquisition of necessary consents, the first author, an experienced speech therapist, extended invitations to all mothers to attend the schools. She elucidated the study's objectives and provided an information sheet and consent form. All participating parents were mothers aged between 28 to 41 years. Subsequently, children whose mothers signed the consent form were enrolled in the study, while others continued with their routine rehabilitation services without alteration.

The psychologist, employed at the Ministry of Education in the Semnan Branch, assessed the children's intellectual quotient using the Lighter IQ test, which determined their eligibility as educable. Subsequently, the twenty-one preschoolers were divided into three groups through systematic randomization. Each group underwent an eight-week intervention comprising three sessions per week, with each session lasting 45 minutes. The comprehensive program designed for ten weeks is detailed in Table 1.

Long-term and Short-term Plans

The research team developed a long-term plan based on the results of all tests and language sample analysis. Emphasizing socio-conversational analysis, the children's pragmatic skills were identified as the primary focus of therapeutic sessions. It was assumed that addressing

Table 1: Details of session plans in different Speech and Language Pathologists-Service Delivery (SLPs-SD)

Week number	Pullout	Consultant	Classroom-based
1	Pretest Evaluation– Group Allocation		
2	- Conversational skills - Asking for, giving, and responding to information - Turn-taking - Eye contact	- Turn-taking - Asking for, giving, and responding to information	- Turn-taking - Eye contact
3	- Introducing and maintaining topics - Making relevant contributions to a topic - Asking questions	-Conversational skills	- Turn-taking
4	- Avoiding repetition or irrelevant information - Asking for clarification - Adjusting language based on the situation or person	- Asking for clarification - Adjusting language based on the situation or person	-Avoiding repetition or irrelevant information
5	- Using humor - Using appropriate strategies for gaining attention and interrupting - Asking for help or offering help appropriately	- Asking for help or offering help appropriately	- Asking for help or offering help appropriately
6	- Offering.responding to expressions of affection appropriately - Facial expression	Offering.responding to expressions of affection appropriately	Offering.responding to expressions of affection appropriately
7	- Body language - Intonation of voice - Body distance and personal space	- Body language - Using appropriate strategies for gaining	- Using appropriate strategies for gaining
8	Repeat the previous exercises	Repeat the previous exercises	Repeat the previous exercises
9	Repeat the previous exercises	Repeat the previous exercises	Repeat the previous exercises
10	Posttest Evaluation- Report Preparation		

pragmatic skills would also impact other language areas. Consequently, implementing this intervention was anticipated to result in an approximate one-year increase in the children's language age.

Intervention Procedures

The most prominent methods for delivering SLP services to enhance language development include clinician-directed, child-centered, and hybrid approaches, considered in both pull-out and classroom-based interventions [5]. However, for the consultation model, the therapist focused on implementing Indirect Language Stimulation (ILS) to assist mothers [Please refer to pages 260-362 in Paul and Norbury for further details [5].

Alterations During the Program

The research team maintained flexibility during the meetings. Although we initially allocated 45 minutes for each therapeutic session in any service delivery model, we were patient and adaptable if any session required more time for various reasons. We actively listened to the mothers, children, and educational collaborators during each session, allowing us to adjust our agenda, long-term plans, short-term objectives, and session plans accordingly. As a result, it was common for us to extend the duration of therapeutic sessions as needed.

Based on the initial evaluation, the research team defined the goals to target for each student. They consistently referred back to the student's curriculum, focusing on goals that would significantly impact the student's ability to learn, speak, or participate. In cases where a goal did not seem to affect the student's progress, the research team monitored it closely and discussed it with the mothers, teachers, and educational collaborators. Given the importance of balancing the time each student spent in their classroom with the time they spent with the SLP to ensure success in the school setting, the research team prioritized addressing challenges that arose for each child accordingly.

One of our main concerns was ensuring the generalization of goals beyond the speech therapy room. Research has shown that pull-out service delivery models can yield significant intervention outcomes, particularly in controlled, structured, and individualized settings. However, achieving generalization beyond the intervention environment may require additional intentional programming. On the other hand, interventions conducted in natural, inclusive communicative contexts, like classrooms, may result in smaller gains but better student use and generalization [28, 29].

To promote generalization, our research team focused on strategies students could apply outside the speech room. For instance, we implemented contextualized therapy approaches, such as narrative intervention, which has led to greater generalization than decontextualized therapy [30].

We knew from the literature that family involvement and student participation were crucial for achieving optimal outcomes in these service delivery models. Therefore, our research team placed significant emphasis on considering the feelings of both the families and the students regarding the SLP services and the type of service delivery.

In cases where a student or mother expressed dissatisfaction, the research team was prepared to make immediate and appropriate adjustments, such as changing the service delivery model or adjusting the days.hours of service delivery. To maintain the cooperation of both the child and the mother, we implemented a token boost system. We also tried to adapt the sessions to support the children's emotional, sensory, or attention regulation needs by incorporating flexibility, providing visual or food reinforcements, offering breaks, and engaging in activities beyond the scope of speech and language goals.

Statistics

All data were entered into SPSS software version

21 for analysis. The normal distribution of data was assessed using the Shapiro-Wilk test. Non-parametric tests, specifically the Kruskal-Wallis test, were utilized to compare the three groups.

Results

The study comprised 21 children with intellectual disabilities randomly assigned to three groups, each receiving different speech therapy service delivery models. Analysis of the means of chronological and non-verbal mental ages revealed no significant differences among the groups (P>0.05) (Table 2).

Tables 3 and 4 present the means and standard deviations of language age and the standard scores of children before and after receiving SLP services. The results indicate no significant differences in the standard mean, percentage, and language age test scores, except for grammar completion scores after the provision of services (P>0.05).

In addition to the scores obtained from the core subtests of TOLD-P:3, composition scores were calculated based on these subtests. Table 5 displays the pre-and post-test scores for each area of language abilities. The analysis revealed that the only significant difference among groups was observed for organizing before intervention; however, this difference diminished after the delivery of services.

The research team was interested in evaluating and comparing the extent of changes observed in each group after receiving speech therapy services under specific SDs. Changes in language age and composition scores were calculated, and the groups were compared based on the magnitude of these changes. Tables 6 and 7 compare the groups regarding the amount of changes observed.

Table 2: Demographic characteristics of the participants

Service Delivery Model	Gender		Total	Chronological age		Non-verbal intellectual age	
	Boy	Girl		Mean	SD*	Mean	SD
Pull-out	4	3	7	8.16	2.12	4.21	0.36
Classroom Based	6	1	7	7.32	1.70	4.48	0.80
Consultant	6	1	7	8.46	1.90	4.90	0.53

*Standard Deviation

Table 3: Comparison of Language age according to the Core Subtests of the Test of Language Development-Persian:3 (TOLD-P:3)

Service Delivery Model	Subtests of TOLD-P: 3											
	Picture vocabulary		Relational vocabulary		Oral vocabulary		Grammatical understanding		Sentence Imitation		Grammatical completion	
	Before	After	Before	After	Before	After	Before	After	Before	After	Before	After
Pull-out	(0.22) 3.11	(0.37) 3.20	(0.00) 3.00	(0.01) 3.00	(0.39) 3.16	(0.38) 3.16	(0.00) 3.00	(0.41) 3.16	(0.00) 3.00	(0.00) 3.00	(0.00) 3.00	(0.00) 2.73
Classroom Based	(0.03) 3.05	(0.36) 3.19	(0.01) 3.00	(0.01) 3.00	(0.04) 3.03	(0.02) 3.02	(0.00) 3.00	(1.14) 3.44	(0.00) 3.00	(0.04) 3.02	(0.01) 3.00	(0.01) 3.00
Consultant	(0.39) 3.21	(0.46) 3.34	(0.00) 3.00	(0.40) 3.16	(0.02) 3.01	(0.03) 3.04	(0.00) 3.00	(0.39) 3.15	(0.00) 3.00	(0.00) 3.00	(0.00) 3.00	(0.00) 3.33
P value	0.499	0.466	0.368	0.683	0.554	0.447	1.00	0.747	1.00	0.122	0.368	0.012

Table 4: Comparison of Standard Scores according to the Core Subtests of the Test of Language Development-Persian:3 (TOLD-P:3)

Service Delivery Model	Subtests of the Test of Language Development-Persian:3 (TOLD-P:3)											
	Picture vocabulary		Relational vocabulary		Oral vocabulary		Grammatical understanding		Sentence Imitation		Grammatical completion	
	Before	After	Before	After	Before	After	Before	After	Before	After	Before	After
Pull-out	(0.90) 4.14	(1.65) 5.57	(0.95) 5.71	(1.07) 6.14	(2.15) 6.57	(1.83) 6.00	(0.49) 2.71	(2.76) 5.43	(0.79) 2.43	(0.95) 2.71	(0.38) 2.14	(2.41) 5.86
Classroom Based	1.11) 3.71	(1.07) 5.14	(0.90) 4.86	(0.90) 6.14	(1.35) 5.14	(1.07) 5.86	(0.38) 2.14	(4.11) 4.39	(1.073) 2.86	(3.05) 4.43	(1.11) 2.71	(1.50) 3.29
Consultant	(2.94) 5.43	(1.62) 6.43	(0.95) 4.71	(1.51) 6.57	(1.35) 4.86	(1.27) 6.43	(0.38) 2.14	(2.81) 4.71	(0.98) 2.57	(1.38) 3.71	(0.38) 2.14	(1.25) 7.71
P value	0.263	0.194	0.135	0.748	0.217	0.744	0.038	0.429	0.732	0.352	0.322	0.002

Table 5: Comparison of composite scores before and after providing services by group

		Compositions											
		Spoken language		Listening		Organizing		Speaking		Semantics		Syntax	
		Before	After	Before	After	Before	After	Before	After	Before	After	Before	After
Service Delivery Model	Pull-out	(7.85) 55.00	(8.99) 68.28	(4.30) 59.86	(12.99) 74.00	(4.65) 59.57	(5..88) 61.29	(7.45) 67.71	(10.03) 76.29	(4.92) 73.71	(5.12) 76.29	(14.84) 29.86	(12.97) 67.00
	Classroom-Based	(6.75) 49.42	(14.66) 61.43	(3.26) 56.57	(15.73) 67.57	(6.53) 54.57	(13.66) 68.26	(7.44) 65.57	(5.93) 69.14	(6.95) 66.00	(3.73) 75.29	(18.28) 30.43	(18.65) 60.14
	Consultant	(6.11) 50.57	(8.21) 74.14	(9.99) 63.71	(10.68) 75.14	(3.63) 51.14	(10.84) 67.57	(5.54) 62.00	(6.37) 82.57	(8.15) 69.86	(8.28) 79.29	(12.37) 25.00	(8.15) 72.86
	P value	0.183	0.145	0.248	0.398	0.021	0.386	0.278	0.015	0.186	0.292	0.489	0.135

Table 6: Changes in language ages based on the core subtests of the Test of Language Development-Persian:3 (TOLD-P:3)

Service Delivery Model	Subtests of the Test of Language Development-Persian:3 (TOLD-P:3)											
	Picture vocabulary		Relational vocabulary		Oral vocabulary		Grammatical understanding		Sentence Imitation		Grammatical completion	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Pull-out	0.09	0.47	0.004	0.01	-0.009	0.02	0.16	0.41	0.00	0.00	-0.27	1.27
Classroom Based	0.15	0.34	0.00	0.00	-0.004	0.03	0.44	1.14	0.02	0.04	-0.004	0.01
Consultant	0.13	0.34	0.16	0.40	0.03	0.04	0.15	0.39	0.00	0.00	0.33	0.49
P value	0.884		0.313		0.135		0.747		0.122		0.011	

Table 7: Changes in language skills abilities based on the compositions of the Test of Language Development-Persian:3 (TOLD-P:3)

Service Delivery Model	Compositions of the Test of Language Development-Persian:3 (TOLD-P:3)											
	Spoken language		Listening		Organizing		Speaking		Semantics		Syntax	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Pull-out	13.29	11.28	14.14	13.99	1.71	4.57	8.57	7.65	2.57	5.47	37.14	10.51
Classroom Based	12.00	13.50	11.00	16.29	13.71	10.70	3.57	9.48	9.29	7.59	29.71	14.23
Consultant	23.57	7.29	11.43	10.89	16.43	12.12	20.57	9.32	9.43	4.11	47.86	17.82
P value	0.050		0.687		0.009		0.017		0.084		0.055	

Discussion

The present study demonstrated the effectiveness of different SLP-SDs in a cohort of 21 children with ID who were randomly allocated into three groups. All three groups exhibited positive changes after receiving the SLP services. Stone reported similar findings which were consistent with this study results [31], who investigated the impact of three SDs (Pull-out, SLP co-teaching, and teacher-SLP independent group) on teaching instructional verbs to three different groups (typical children, children from low socio-economic backgrounds, and children with disabilities). It was observed that all children learned the targeted vocabulary regardless of the specific delivery model utilized.

Initially, we hypothesized that children in the pull-out SD would exhibit significant changes in all measurements. However, the results were unexpected. While the pretest comparisons between groups did not reveal any significant differences in core subtests and compositions, after receiving different SDs, a significant difference was observed among groups in the grammatical completion core subtest. This significance stemmed from a notable increase in the grammatical completion score among children who received consultant services. Additionally, the posttest comparison of compositions showed a significant increase in the 'speaking' score (derived from oral vocabulary and grammatical completion) among children in the consultant SD. In contrast, the other two groups did not exhibit such changes.

Regarding the changes observed in the core subtests and compositions within each group, children in the consultant SD displayed significant and positive increases across all measures. These findings contradict our initial hypothesis and are not consistent with similar studies conducted by Throneburg et al. (2000), Farber and Klein (1999), and Ellis et al. (1995) [32-34]. These studies found that collaborative SD, where an SLP and teacher work together, resulted in better student outcomes than the traditional pull-out approach and.or consultative model. However, no significant differences were observed among groups based on the SLP-SDs utilized in Stone's study.

There are several reasons why our results diverged from previous findings. Firstly, we focused on a specific group of children with unspecified intellectual disabilities. In contrast, previous studies applied different SDs to children in kindergarten or primary schools with or without a need for SLP services. Moreover, our participants' mothers were well-informed about their children's rehabilitation and educational processes. This is significant as our study was conducted shortly after the COVID-19 pandemic, during which many routine services were provided through telehealth or virtual platforms, requiring mothers to take an active role in working with their children.

Additionally, the literature suggests that several important factors may influence the outcomes of SDs. These include characteristics of the student, such as the nature and severity of language problems; environmental factors, including cultural and linguistic considerations; family and community support; and availability of resources [35-38]. The organizational factors include the educational frameworks, policies, and values of the province or territory, school district, and individual schools. These also encompass each teacher's instructional style, expectations, and understanding of the scope of practice and role of S-LTs in schools [8, 39]. Finally, SLP factors include staffing levels, the availability of resources (such as classroom and curriculum-based materials), administrative support and space, access to other SLP service providers in the community, caseload, and workload demands, responsibilities assigned by school administrators, time required for travel between schools, the number of students in need of SLP services, and the complexity of their needs. This study did not examine the long list of potential influential factors provided here. However, future studies might consider the effectiveness of SDs in addressing these factors.

Even though the research team endeavored to provide a rich and comprehensive intervention, the observed changes in language age were not deemed sufficient to warrant discontinuation of SLP services for these children. This finding aligns with previous research, highlighting the challenge of identifying a universally optimal SLP

service delivery model. The variability across schools, classrooms, staff members, and students, coupled with the diverse range of available service delivery options, underscores the complexity of addressing speech, language, communication, and literacy issues [8].

While some evidence suggests the efficacy of collaborative, functional, curriculum-based, and inclusive intervention approaches [8, 40, 41], further exploration of these delivery models in diverse populations is warranted. Our collaborative efforts with parents and teachers proved invaluable in adapting, implementing, and assessing the effectiveness of SLP-SDs. However, several limitations may have impacted the outcomes: reliance on an older version of a single standardized language test, limited access to children with ID who had speaking skills, and the inability to generalize our results to children with other disorders or those lacking oral language skills.

Conclusion

The findings of this study indicate that SLP services, irrespective of their service delivery models (SDs), positively impact the language skills of children with ID. However, the consultant SD emerged as the most effective among the three compared (pull-out, classroom-based, and consultant) for preschoolers with ID.

Acknowledgment

The authors extend their gratitude to the Ministry of Education, Semnan Branch, for their support, as well as to the teachers, parents, students, and all school boards who contributed to the successful execution of this study.

Conflict of interest: the authors of this manuscript have no conflict of interest to declare

Authors' Contribution

Conceptualization, [M.A and M.S]; Methodology, [all authors]; Investigation [M.A]; Writing – Original Draft [all authors]; Writing – Review and Editing [all authors]; Funding Acquisition and Resources and Supervision [M.S and M.K]

Conflict of Interest: None declared.

References

1. American Speech-Language H, Association,. Types of Services 2023a [Available from: https:..www.asha.org.NJC.Types-of-Services..
2. American Speech-Language HA. School-Based Service Delivery in Speech-Language Pathology USA: ASHA; 2023b [Available from: https:..www.asha.org.slp.schools.school-based-service-delivery-in-speech-language-pathology..
3. Farquharson K, Therrien M, Barton-Hulsey A, Brandt AF. How to Recruit, Support, and Retain Speech-Language Pathologists in Public Schools. Journal of School Leadership. 2020;32(3):225-45.
4. American Speech-Language HA. Service Delivery Models and SLPs in Schools. In: Association AS-L-H, editor. Let's Talk. USA: American Speech-Language-Hearing Association; 2010.
5. Paul R, Norbury C. Language disorders from infancy through adolescence: Listening, speaking, reading, writing, and communicating. USA: Elsevier Health Sciences; 2012.
6. Ebbels SH, McCartney E, Slonims V, Dockrell JE, Norbury CF. Evidence-based pathways to intervention for children with language disorders. International journal of language & communication disorders. 2019;54(1):3-19.
7. Elenko KR. School-Based Speech-Language Pathologist Collaborative Practice: A Literature Review. USA: University of Montana; 2020.
8. Archibald LMD. SLP-educator classroom collaboration: A review to inform reason-based practice. Autism & Developmental Language Impairments. 2017;2:2396941516680369.
9. Cirrin FM, Schooling TL, Nelson NW, Diehl SF, Flynn PF, Staskowski M, et al. Evidence-based systematic review: effects of different service delivery models on communication outcomes for elementary school-age children. Language, Speech, and Hearing Services in Schools. 2010;41(3):233-64.
10. Meaux AB, Norris JA. Curriculum-Based Language Interventions: What, Who, Why, Where, and How? Language, Speech, and Hearing Services in Schools. 2018;49(2):165-75.
11. Center for planning human resources and administrative affairs. Ministry of Education: how to organize human resources. Tehran: Ministry of Education; 2021.
12. Islamic republic of Iran Exceptionl Education Organization. Providing speech therapy services through 386 speech therapists Tehran: Islamic republic of Iran Exceptionl Education Organization; 2021 [
13. Maasoomi Jahandizi H. Prevalence of speech disorders among zanjan primary school students in 2000. Journal of Advances in Medical and Biomedical Research. 2001;9(36):17-21.
14. Sadollahi A, Kasbi F, Genabi MS, Zanjani MO, Eftekhari Z, Ghorbani R. Survey of the prevalence of the articulation disorders in primary-school children (semnan-2004). Koomesh. 2004;6(1):57-62.
15. Mousavi SA, Valinezhad M, Shirkarami F. An investigation of the prevalence of learning disabilities in primary schools. The first Islamic- Human Conference2016.
16. Yavari A, Fatehi F, Dalvand H, Valizadeh A, Moradzadeh R, Mirhoseini FS. Prevalence of Speech Disorders in Arak Primary School Students, 2014-2015. HBI_Journals. 2016;19(6):87-94.
17. Soleimani A, Mohammadi H, Khazayi H, Ertiyahi F. The prevalence of speech disorders in students, Kermanshah, 2008-2009. Journal of Kermanshah University of Medical Sciences. 2011;15(3):213-9 [Persian].
18. Enderby P, Davies P. Communication disorders: planning a service to meet the needs. The British journal of disorders of communication. 1989;24(3):301-31.
19. American Speech-Language-Hearing Association. Annual workforce data: 2021 ASHAcertified audiologist- and speech-language pathologist-to-population ratios. USA: ASHA; 2022 6.6.2023.
20. Brandel J, Frome Loeb D. Program intensity and service delivery models in the schools: SLP survey results. Language, Speech, and Hearing Services in Schools. 2011;42(4):461-90.
21. Biancone TL, Farquharson K, Justice LM, Schmitt MB, Logan JA. Quality of language intervention provided to primary-grade students with language impairment. Journal of communication disorders. 2014;49:13-24.
22. Swaminathan D, Farquharson K. Using response to intervention for speech sound disorders: Exploring practice characteristics and geographical differences. Perspectives of the ASHA Special Interest Groups. 2018;3(16):53-66.
23. Cirrin FM, Gillam RB. Language intervention practices for school-age children with spoken language disorders: a systematic review. Lang Speech Hear Serv Sch. 2008;39(1):S110-37.
24. Boyle JM, McCartney E, O'Hare A, Forbes J. Direct versus indirect and individual versus group modes of language therapy for children with primary language impairment: principal outcomes from a randomized controlled trial and economic evaluation. International Journal of Language Communication Disorders. 2009;44(6):826-46.
25. Lowe H, Henry L, Müller LM, Joffe VL. Vocabulary intervention for adolescents with language disorder: a systematic review. Int J Lang Commun Disord. 2018;53(2):199-217.
26. Heisler L, Thousand J. A Guide to Co-Teaching for the SLP: A Tutorial. Communication Disorders Quarterly. 2019;42:152574011988631.
27. Hasan Zadeh S, Minayi A. The test of language development: TOLD-P:3. Tehran: Education Research Institute; 2010.
28. Fey ME. Language intervention with young children. Boston: Allyn & Bacon; 1986.
29. McCauley RJ, Fey MJ, Gillam RJ. Treatment of language disorders

in children. Baltimore: Paul. H. Brookes; 2017.
30. Gillam SL, Gillam RB, Reece K. Language Outcomes of Contextualized and Decontextualized Language Intervention: Results of an Early Efficacy Study. Language, Speech, and Hearing Services in Schools. 2012;43:276-91.
31. Stone L. The effects of three service delivery models on vocabulary learning by second-grade children. USA: University of Kentucky; 2020.
32. Throneburg R, Calvert L, Sturm J, Paramboukas A, Paul P. A Comparison of Service Delivery Models: Effects on Curricular Vocabulary Skills in the School Setting. American journal of speech-language pathology. 2000;9(1):10-20.
33. Farber JG, Klein ER. Classroom-based assessment of a collaborative intervention program with kindergarten and first-grade students. Language, Speech & Hearing Services in Schools. 1999;30(1):83-91.
34. Ellis L, Schlaudecker C, Regimbal C. Effectiveness of a collaborative consultation approach to basic concept instruction with kindergarten children. Language, Speech & Hearing Services in Schools. 1995;26(1):69-74.
35. Yaruss JS, Coleman CE, Quesal RW. Stuttering in school-age children: a comprehensive approach to treatment. Language, Speech, and Hearing Services in Schools. 2012;43(4):536-48.
36. Brosseau-Lapré F, Greenwell T. Innovative Service Delivery Models for Serving Children with Speech Sound Disorders. Seminar in Speech Language. 2019;40(2):113-23.
37. Hoffman LM, Ireland M, Hall-Mills S, Flynn P. Evidence-based speech-language pathology practices in schools: findings from a national survey. Language, Speech, and Hearing Services in Schools. 2013;44(3):266-80.
38. Justice LM, Logan J, Schmitt MB, Jiang H. Designing Effective Speech-Language Interventions for Children in the Public Schools: Leverage the Spacing Effect. Policy Insights from the Behavioral and Brain Sciences. 2016;3(1):85-91.
39. Westby C. There's more to passing than knowing the answers. Language, Speech & Hearing Services in Schools. 1997;28(3):274.
40. Ehren BJ. Maintaining a Therapeutic Focus and Sharing Responsibility for Student Success: Keys to In-Classroom Speech-Language Services. Lang Speech Hear Serv Sch. 2000;31(3):219-29.
41. Whitmire K. The Evolution of School-Based Speech-Language Services: A Half Century of Change and a New Century of Practice. Communication Disorders Quarterly. 2002;23(2):68-76.

JRSR 11 (2024) 102-108

Journal of Rehabilitation Sciences and Research

Journal Home Page: jrsr.sums.ac.ir

Original Article

Enhancing Independence in Activities of Daily Living, Cognitive, and Physical Skills for Elderly with Dementia: A Randomized Controlled Trial of Meaningful Task-Oriented Intervention

Farzad Rabiei[1], MSc; Malahat Akbarfahimi[2*], PhD; Mahtab Roohi-Azizi[3], PhD; Marjan Ghandi[4], MSc

[1]Department of Occupational Therapy, School of Rehabilitation, Rehabilitation Research Center, Iran University of Medical Sciences, Tehran, Iran
[2]Department of Occupational Therapy, School of Rehabilitation Sciences, Neuroscience Research Center, Iran University of Medical Sciences, Tehran, Iran
[3]Rehabilitation Research Center, Department of Rehabilitation Sciences, School of Rehabilitation Sciences, Iran University of Medical Sciences, Tehran, Iran
[4]Department of Health Technology Assessment, Faculty of Management and Medical Information Sciences, Kerman University of Medical Sciences, Kerman, Iran

ARTICLE INFO

Article History:
Received: 03/01/2023
Revised: 08/05/2023
Accepted: 18/06/2023

Keywords:
Activities of daily living
Cognitive function
Dementia
Physical functional performance
Task

Please cite this article as:
Rabiei F, Akbarfahimi M, Roohi-Azizi M, Ghandi M. Enhancing Independence in Activities of Daily Living, Cognitive, and Physical Skills for Elderly with Dementia: A Randomized Controlled Trial of Meaningful Task-Oriented Intervention. JRSR. 2024;11(2):102-108. doi: 10.30476/JRSR.2023.97679.1340.

ABSTRACT

Background: Dementia is recognized as a neurodegenerative disease that gradually causes serious cognitive, motor, and functional impairments in affected individuals. This study explored the impact of a meaningful task-oriented intervention on independence in activities of daily living, cognitive status, and physical abilities, including gait speed and balance, among elderly patients diagnosed with mild to moderate dementia.

Methods: In this randomized controlled trial, 40 participants aged 60-70, with a Functional Assessment Staging Tool (FAST Scale) score of 1-5, were recruited. They were randomly assigned to either a control group (n=20) receiving standard care, including medication and routine consultation, or an intervention group (n=20) receiving standard care along with eight 45–60-minute sessions of task-oriented interventions. These interventions were centered around familiar daily life activities in the home environment and were conducted twice a week. The primary outcome measure was the participants' independence in activities of daily living, assessed using the Barthel Index. Secondary outcome measures included cognitive function, evaluated using Addenbrooke's Cognitive Examination-Revised, and physical performance, assessed through the Timed Up and Go test, 10 Meter Walk Test, and Berg Balance Scale.

Results: The meaningful task-oriented intervention demonstrated significant improvements in independence in activities of daily living ($P<0.01$) compared to the control group. Additionally, improvements were observed in cognitive function and physical performance, including balance, lower limb strength, and walking speed ($P<0.05$).

Conclusion: The integration of meaningful task-oriented interventions centered around familiar activities within the home environment appears to offer significant benefits for elderly patients with dementia. By engaging in tasks that resonate with their daily routines, these interventions can support the maintenance of essential skills and foster a sense of independence among affected individuals.

Introduction

Dementia is recognized as a neurodegenerative disease that causes irreversible cognitive, functional, and behavioral deterioration. Patients with dementia experience a range of cognitive and non-cognitive symptoms, including memory impairment, language difficulties, perceptual and motor impairments, disorientation, and executive function impairments [1]. They may also experience motor dysfunctions,

*Corresponding author: Malahat Akbarfahimi, PhD; Department of Occupational Therapy, School of Rehabilitation Sciences, Iran University of Medical Sciences, Madadkaran Alley, Shah Nazari St, Madar Square, Mirdamad Blv, Tehran, Iran. **Tel:** +98 9123362925; **Email:** akbarfahimi.m@iums.ac.ir

such as muscle weakness, imbalance, and diminished mobility, particularly in the lower extremities. Other non-cognitive symptoms include behavioral and psychological symptoms of dementia (BPSD), such as agitation, aggression, depression, wandering, apathy, and sleep disorders [2]. These changes result in substantial economic burdens, engender dependency in activities of daily living, and increase the caregiving load [3].

The primary aim of interventions for individuals with dementia is to alleviate cognitive impairments, mood fluctuations, and behavioral disturbances while also slowing the progression of cognitive decline. Two primary approaches - non-pharmacological and pharmaceutical - are employed to achieve this objective [2, 4] .Despite limited or inconclusive evidence regarding the efficacy of non-pharmacological interventions, they are frequently utilized due to their cost-effectiveness and safety profile [2, 5] .Among non-pharmacological interventions, the literature suggests that home-based occupational therapy may yield positive outcomes for patients with dementia and their caregivers by enhancing their involvement in meaningful activities, roles, and relationships [6]. Occupational therapists aim to optimize the alignment between occupation, the individual's capabilities, and their physical and social surroundings [7]. This involves assisting patients with dementia in identifying meaningful activities, simplifying them to enhance engagement, and reducing environmental stressors and distractions [8]. Individuals with mild dementia perceive activities as meaningful when they experience a sense of connection to themselves, others, and their environment [9, 10].

Task-oriented interventions have effectively enhanced motor behavior among individuals with cognitive disorders [11] However, meaningful task-oriented interventions go beyond standard task-based approaches by utilizing everyday activities that hold personal significance to patients, as outlined by Hubbard et al. [12] Literature suggests that incorporating individualized therapy goals centered around specific tasks may result in decreased disability levels in patients with dementia; nevertheless, it remains unclear whether patients can generalize learned skills and autonomously initiate tasks in their natural settings [13]. In a case study conducted by Cirio et al., Task-Oriented Motor Practice (STOMP) enhanced functional skills in a patient diagnosed with moderate dementia with Lewy bodies. The authors propose that STOMP has the potential to assess and address occupational performance deficits in individuals with dementia and warrants further exploration [13].

Likewise, Son et al. demonstrated that task-oriented activities can enhance hand function, cognitive function, and self-expression in elderly individuals with early-stage dementia [14]. Additionally, Gbiri et al. found that Progressive Task-oriented Circuit Training is superior to conventional treatment with home exercise programs in enhancing cognition, improving functional performance, and fostering societal participation in rehabilitating individuals with dementia [15].

In conclusion, the evidence suggests that task-oriented interventions centered around familiar activities within the home environment may hold promise in improving outcomes for individuals with dementia. However, further research is warranted to validate their efficacy and explore their long-term effects and applicability across different settings. This study serves as an initial exploration into the potential benefits of such interventions and lays the groundwork for future investigations in this area.

Moreover, the innovation of this study lies in developing a comprehensive program that utilizes meaningful task-oriented interventions based on activities commonly performed in patients' homes. This program targets cognitive and physical abilities to enhance independence in daily activities and improve walking speed, lower extremity strength, and balance. While prior research has shown the positive impacts of task-oriented training on the cognitive and functional abilities of dementia patients, this study specifically focuses on implementing these interventions within the home setting. The authors posit that this approach has the potential to be more effective than traditional methods, which may not always align with patients' daily routines or may not consider the unique aspects of their home environment.

The main aim of this study was to evaluate the influence of meaningful task-oriented interventions on patients' independence in activities of daily living. Secondary objectives encompassed assessing their impact on cognitive status and physical abilities, including gait speed, functional lower extremity strength, and balance.

Materials and Methods

Participants

Forty patients diagnosed with dementia were enrolled in the study according to the Diagnostic and Statistical Manual of Mental Disorders, 5th edition (DSM-5). The diagnosis was confirmed by a specialist neurologist with brain and cognition expertise at a clinic in Tehran, Iran. Inclusion criteria comprised individuals aged between 60 and 70 years, with an educational level of more than seven years, a FAST score ranging from 1 to 5, and a Mini-Mental Status Test score below 18 [16]. Additionally, participants were required to reside with their families in their own homes, possess the ability to comprehend and adhere to one-step commands, and exhibit motor, functional, and cognitive impairments, as reported by their families. Adequate vision and hearing with correction were also necessary. Exclusion criteria included the presence of delirium, Parkinson's disease, and receptive or global aphasia.

Setting

All pre-tests, post-tests, and intervention sessions were conducted in the participants' homes, with their caregivers or family members present, ensuring a calm and motivating environment. Intervention sessions were scheduled at times when participants were most cooperative and alert. This clinical trial was approved by the Ethical Committee of the Iran University of Medical Sciences (IR.IUMS.REC 1398.1010) and registered in the Iranian Registry of Clinical Trials IRCT20191027045253N1 (https://irct.behdasht.gov.ir/trial/43327). Both participants and their significant others

provided written informed consent before participating in the study.

Intervention

The intervention group comprised 20 participants who underwent eight sessions twice weekly, lasting 45-60 minutes each, from April to November 2019. In the initial session, participants were briefed on the intervention's objectives, and feedback was gathered on selecting training goals based on the needs of the clients and their families. Pre-tests were administered before the first session, with post-tests conducted on the day following the final session.

Randomization, Allocation, Concealment, and Blinding

An assessor, unaware of the aims of the current research, objectively evaluated the eligibility of 40 participants using the FAST test, stages 1 to 5. Eligible participants were randomly assigned to either the intervention or control group in a 1:1 ratio. The intervention group received the designed meaningful task-oriented interventions in addition to medication, while the control group solely received medication. Both groups received standard psychological consultations from brain clinics. A random number generator and sealed opaque envelopes were employed to ensure unbiased group allocation. Unaware of the study's objectives, an impartial individual facilitated the number generation for group allocation and concealed the allocation using sealed opaque envelopes.

Procedure

The study's aims and objectives were communicated to the participants, who were informed of their right to withdraw from the study at any time without facing adverse consequences. To minimize bias in the study results, a blinded assessor, unaware of the study's aims and objectives, was provided with the participants' FAST test scores to assign them to either the intervention or control group. Subsequently, cognitive and physical abilities and functional independence were evaluated in a randomized order. Following this, an occupational therapist, blinded to both the assessment results and the study's aims, conducted the intervention sessions based on Table 1. The flowchart outlining the participants' enrollment and progression is presented in Figure 1. The five key elements of the designed meaningful task-oriented activities, which are considered crucial components, include intervention sessions in the presence of a family member, repetitive task performance with feedback, errorless practice, and establishing a close rapport. Additionally, this program's significant aspect was preventing fatigue during interventions and incorporating engaging tasks [17].

Outcome measures

Primary Outcome Measure

Barthel Index

The Barthel Index is a comprehensive measure of functional disability that evaluates the patient's ability to perform ten daily activities, which can be classified under self-care abilities (e.g., feeding, grooming, bathing, dressing, continence, and toileting) and mobility (e.g., ambulation, transferring, and climbing stairs). The total score ranges from 0 to 100, with higher scores indicating

Table 1: The Task-Oriented Intervention Program Based on Occupational Performance

Sessions	Home-based tasks
First	The session begins with warm-up exercises, followed by a 15-minute supervised walk led by an occupational therapist to prepare tea and serve it to family members. Isotonic exercises are conducted against an external force in the patient's lower extremities, involving pushing and pulling a chair. The home environment is adapted to various obstacles, and the patient is guided through navigating them individually while counting numbers, all under the therapist's guidance. The chosen household chore for this session is breakfast preparation.
Second	The session starts with warm-up exercises and a 15-minute walk simulated by sweeping the house. Strengthening exercises entail sitting and standing on a chair for 15 repetitions. Following a short break, the patient is tasked with opening the refrigerator door and memorizing the correct location of the items inside. The therapist then rearranges the items and prompts the patient to return them to their correct places. Cleaning the refrigerator is designated as the household chore for this session.
Third	The session begins with warm-up exercises, followed by a task involving various kitchen utensils, such as spoons, glasses, and plates. These utensils are strategically hidden around the house while the patient observes. The therapist then prompts the patient to locate and retrieve each utensil by recalling its location. Next, the patient is guided to lift the opposite leg while seated on a chair and count down from 50 to 5 by fives. After a brief rest, the patient is asked to stand in a stationary position and identify and retrieve various objects presented by the therapist in different directions while verbalizing their names. Towards the end of the session, the patient is encouraged to kick a ball towards a designated target using their foot. Categorizing kitchen utensils is designated as the household chore for this session.
Fourth	The session begins with warm-up exercises, followed by a task involving walking in tandem while naming the objects in the patient's surroundings. After a brief rest, the patient is instructed to walk around the house with long strides, counting from 30 to 1. A set of kitchen utensils is then placed on the table, and the patient is asked to categorize each utensil and return it to its designated place. Exploring familiar objects at home and correctly placing them in their appropriate locations is designated as the household chore for this session.
Fifth	Following warm-up exercises, if a yard is available, the therapist guides the patient to attend to gardening tasks such as weeding, planting, and watering the garden. If no yard is available, the patient can perform these tasks using flowerpots at home. Planting a flower is designated as the household chore for this session.
Sixth	After the warm-up exercises, the patient is directed to prepare their preferred meal by selecting the required ingredients and measuring them, with guidance from the therapist and family members. The household chore selected for this session is preparing lunch.
Seventh	Following the warm-up exercises, the patient is requested to clear the food table and bring the utensils to the kitchen. Then, the patient is instructed to wash the dishes while standing on a platform with one foot, ensuring they are correctly placed in their designated location after washing. The selected household chore for this session is dusting and sweeping the home.
Eighth	After the warm-up exercises, the patient accompanies the therapist for a walk in the park and subsequently goes to the supermarket to purchase necessary household items, completing all payment procedures independently. The selected household chore for this session is going shopping with the therapist.

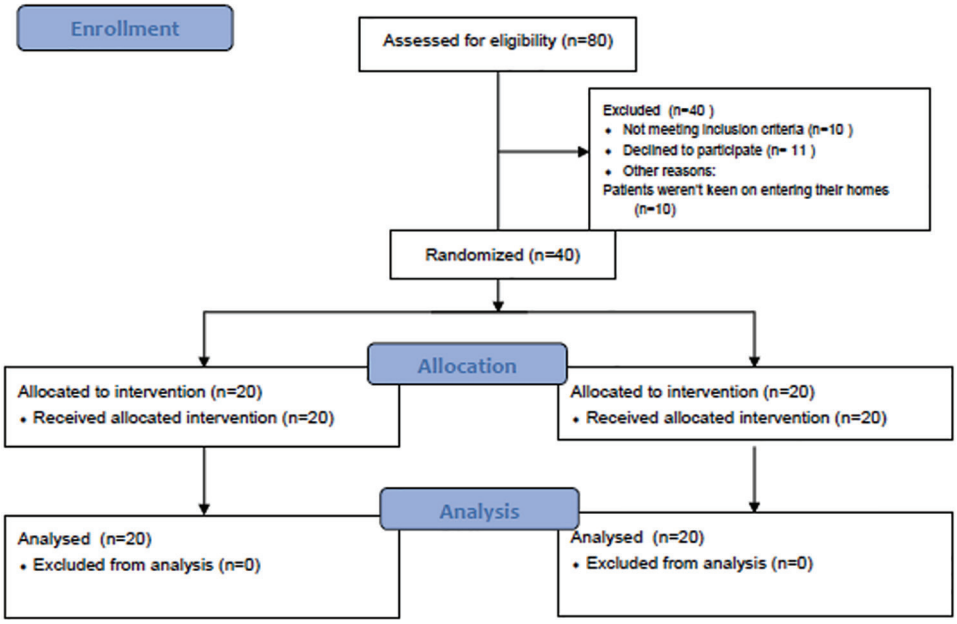

Figure 1: Flowchart of the study.

better physical functioning and greater independence, while zero indicates complete dependence. The Iranian version of the Barthel Index has demonstrated a significant reliability coefficient of 0.938, indicating its clinical utility [18].

Secondary Outcome Measures

Addenbrooke's Cognitive Examination (ACE)

The Addenbrooke's Cognitive Examination (ACE) is a specific screening instrument developed for the early detection of dementia. Unlike the Mini-Mental State Examination (MMSE), the ACE emphasizes executive function over verbal abilities. With an administration time of approximately 15-20 minutes and high reliability and diagnostic accuracy, the ACE is a suitable instrument for clinicians and general clinical services that prioritize accuracy in diagnoses. A score of 76 is considered the optimal cut-off point to distinguish dementia cases from normal subjects, with a sensitivity of 0.92 and a specificity of 0.93 [19].

Timed Up and Go Test

The Timed Up and Go (TUG) test assesses the patient's mobility by requiring them to stand up from a chair, walk 3.0 meters at a comfortable pace to a designated mark on the floor, turn around at the mark, walk back to the starting point, and return to a seated position in the chair. The test score is the time the patient takes to complete the test. The TUG has demonstrated high interrater and interrater reliability, making it a reliable tool for assessing mobility [20].

The 10-Meter Walk Tests (10MWT)

The 10-Meter Walk Test (10MWT) is a suitable instrument for evaluating gait capacity in patients with various neurological conditions, including dementia. This test is useful for assessing and investigating gait capacity in such patients [21].

Berg Balance Scale (BBS)

The Berg Balance Scale (BBS) was initially developed to assess functional balance in older adults. The BBS consists of 14 items, each graded on a 5-point Likert scale (0 to 4), representing varying levels of effort, with a total score ranging from 0 to 56. Higher scores indicate higher levels of functional balance. The BBS takes 10 to 20 minutes to complete and can be used to describe the balance of older adults and detect changes in balance following an intervention program or a disease process [22].

Statistical Analysis

The statistical analysis was conducted using SPSS, version 16.0, SPSS Inc., Chicago, IL, USA. Non-parametric variables such as gait speed, functional lower extremity strength, balance, performance in activities of daily living, and functional and cognitive status were compared using the Mann-Whitney U test. Pre- and post-test data within each group were compared using the Wilcoxon Signed Ranks Test. The significance level was set at P=0.05, and familywise adjustments for multiple comparisons were made using the Error-Rates-Method. Significant differences between the test and control groups were identified. Cohen's d was calculated, with 0.20 indicating a small effect size, 0.50 indicating a medium effect size, and 0.80 indicating a large effect size [23].

Results

The analysis results involving 40 patients with dementia who participated in the study are summarized in Table 2. According to the table, there were no significant differences observed between the intervention group (comprising ten males and ten females) and the control group (comprising seven males and 13 females) concerning sex, age, and pretest scores of all variables, except for the chair stand (P>0.05). Additionally, based on the FAST, the distribution of participants in each group was as follows: 2:3, 7:10, and 11:7 for FAST stages 3, 4, and 5, respectively, with no significant difference between the groups for stages 3 and 4, each having 5 participants in both groups of the study (P=0.17).

Table 2: The Mean (SD) of Participant Characteristics in the Control and meaningful Task-Oriented Intervention Group at the Baseline

Characteristic	Control	Intervention.	P value
	Mean (SD)	Mean (SD)	
Age	79 (8.02)	74.35 (7.09)	0.06
BI	66.5 (16.31)	72.75 (20.16)	0.19
TUG	18.80 (9.26)	18.2 (8.81)	0.70
BBS	43.1 (11.78)	41.6 (13.74)	0.68
10M	19.6 (6.87)	21.1 (6.35)	0.37

Data were presented as mean (standard deviation). *Mann-Whitney U; ** Independent T; BI: Barthel index; TUG: timed up and go; BBS: Berg balance scale; 10M: 10-meter test

Table 3: The Analysis of Personal Independency, Cognitive Status, Gait Speed, Functional Lower Extremity Strength, and Balance Scores in the Intervention Group (n=20) and Control Group (n=20)

	Control G.		Within G.	Intervention G.		Within G.	Between G. after treatment		
	Baseline Mean (SD)	Outcome Mean (SD)	P	Baseline Mean (SD)	Outcome Mean (SD)	P	Mean difference (SE)	P	Effect size
BI	66.5 (16.31)	63.25 (14.26)	0.01*	72.75 (20.2)	72.76 (20.16)	1	-9.5 (5.22)	0.004**	0.21
ACE-R	0.40 (0.16)	0.41 (0.17)	1	0.54 (0.17)	0.59 (0.17)	0.003*	-0.45 (0.19)	0.001	0.29
TUG (sec)	18.80 (9.26)	20.30 (9.91)	0.01*	18.2 (8.81)	16.25 (8.81)	<0.001*	4.05 (2.96)	<0.001**	0.52
BBS	43.1 (11.78)	40.45 (11.02)	0.003*	41.6 (13.74)	44.45 (15.27)	0.001*	-4 (4.21)	<0.001**	0.62
10M (m/s)	19.6 (6.87)	20.9 (6.92)	0.01*	21.1 (6.35)	19.39 (6.78)	0.002*	1.6 (2.16)	<0.001**	0.48

G: Group; Data were presented as mean (standard deviation) and Mean difference (Std. Error Difference). *Wilcoxon Signed Ranks Test; ** Mann-Whitney U; BI: Barthel index; TUG: timed up and go; BBS: Berg balance scale; 10M: 10-meter test

To precisely evaluate the outcomes of the primary and secondary interventions, significant differences between the two groups and the gain difference (post-test score compared to baseline score) were calculated.

Primary Outcome

In the intervention group, the total score of the Barthel Index, as the primary outcome, remained unchanged (P=1); however, in the control group, the performance in activities of daily living (ADL) significantly diminished (P=0.012). The results of the Mann-Whitney U test indicated a significant difference (Z=-2.85, P<0.003, effect size=0.21) in total Barthel Index scores between the two groups (Table 3).

Secondary Outcomes

As depicted in Table 3, the mean post-test score of the BBS decreased in the control group while increasing in the intervention group, with significant differences observed between the two groups. Additionally, the two groups' gain difference in BBS scores showed a significant distinction, as indicated by the Mann-Whitney U test. Furthermore, the post-test duration for the TUG and the 10-meter walk test (10MWT) increased in the control group. They decreased in the intervention group, highlighting a significant difference between them. The two groups' gain difference between TUG and 10MWT scores also exhibited significant disparities according to the Mann-Whitney U test results. Moreover, although the mean score of the Addenbrooke's Cognitive Examination-Revised (ACE-R) post-test increased in both groups, the difference was significant only in the intervention group. The two groups' gain difference between ACE-R scores was also significantly different based on the Mann-Whitney U test results.

Discussion

The primary focus of this study was personal independence, assessed through the Barthel Index (BI). Results indicated a significant difference in the BI scores between the intervention and control groups, aligning with findings from Bennett et al.'s systematic review, which highlighted the efficacy of home-based occupational therapy in enhancing independence in ADL and instrumental activities of daily living (IADL) among individuals with moderate-stage dementia [6]. However, a closer examination within each group revealed contrasting trends. While the intervention group showed a non-significant increase in BI scores post-test, the control group experienced a significant decrease. This suggests that the task-oriented interventions implemented in our study may have contributed to maintaining the participants' current functional status. In contrast, a lack of similar engagement in the home environment led to functional decline in the control group. Although the interventions may not have reversed the progression of dementia, they likely facilitated the application of remaining skills and abilities during daily activities. Moreover, conducting familiar tasks in their home environment likely boosted participants' motivation and indirectly educated family members on better supporting the patient. Family involvement is crucial in implementing tailored interventions aimed at preserving functional abilities. By equipping families with task breakdown techniques and providing appropriate cues, individuals with dementia can engage more autonomously in meaningful activities, enhancing their overall quality of life and satisfaction.

The Addenbrooke's Cognitive Examination-Revised (ACE-R) evaluated cognitive function as a secondary outcome. Given the progressive nature of dementia, improvements in cognitive function were not anticipated. However, intriguingly, the intervention group exhibited increased ACE-R scores, whereas the control group showed no significant change. This unexpected finding suggests that task-oriented interventions involving daily

activities and chores may have compelled patients to utilize their executive function abilities and tap into their remaining cognitive capacities. It's important to recognize that cognitive impairments can significantly impact personal independence in individuals with dementia. This underscores the need to account for cognitive status as a critical confounder in studies assessing cognitive skills in this population [24]. Indeed, the structured tasks implemented in this study, encompassing routine daily activities, appeared to sustain outcomes across various domains, including activities of daily living, functional capacity, and cognitive status, among patients with mild to moderate dementia.

Physical function was evaluated through gait speed and balance as secondary outcomes. Interestingly, the results indicated a decrease in gait speed within the intervention group, contrasting with an increase observed in the control group. This divergence may stem from the higher level of physical activity undertaken by the intervention group, aligning with existing evidence [25]. Moreover, improvements were noted in the intervention group regarding balance, with moderate effect sizes observed across all components of the BBS test. In contrast, a decline was observed in the control group. It's important to note that a lack of motivation and reluctance to engage in daily living activities can contribute to significant deficits in balance, muscle weakness, and diminished walking speed [26].

In conclusion, meaningful task-oriented interventions can help patients use their remaining abilities and prevent secondary disability stemming from dementia progression. The study findings underscore the efficacy of tailored interventions grounded in occupational performance principles, highlighting improvements in functional outcomes, including activities of daily living independence, balance, and cognitive status among dementia patients. Future research endeavors should delve into the long-term effects of these interventions to further elucidate their impact and the effect of this approach in their caregivers [27]. The absence of a control group receiving alternative forms of occupational therapy intervention or standard care presents a limitation in interpreting the effectiveness of the interventions in this study. Additionally, resource constraints restricted the ability to expand the number and duration of intervention sessions, potentially constraining the impact on functional outcomes. Future research endeavors should aim to mitigate these limitations by exploring optimal frequencies and durations of intervention sessions and facilitating comprehensive comparisons of the efficacy of task-oriented interventions.

Conclusion

While this study offers valuable insights into the potential benefits of meaningful task-oriented interventions for enhancing functional outcomes in patients with dementia, addressing the outlined limitations in future research will be crucial to bolster the rigor and generalizability of its findings.

Conflict of Interest: None declared.

References

1. Kiselica AM, Benge JF. Quantitative and qualitative features of executive dysfunction in frontotemporal and Alzheimer's dementia. *Appl Neuropsychol Adult*. 2021;**28** (4):449-63. doi:10.1080/23279095.2019.1652175. [PubMed:31424275].
2. Arvanitakis Z, Shah RC, Bennett DA. Diagnosis and Management of Dementia: Review. *JAMA*. 2019;**322** (16):1589-99. doi:10.1001/jama.2019.4782. [PubMed:31638686].
3. Huggins M, Pesut B, Puurveen G. Interventions for Caregivers of Older Adults with Dementia Living in the Community: A Rapid Review of Reviews. *Can J Aging*. 2023:1-9. doi:10.1017/S0714980823000016. [PubMed:36799030].
4. Cho E, Shin J, Seok JW, Lee H, Lee KH, Jang J, et al. The effectiveness of non-pharmacological interventions using information and communication technologies for behavioral and psychological symptoms of dementia: A systematic review and meta-analysis. *Int J Nurs Stud*. 2023;**138**:104392. doi:10.1016/j.ijnurstu.2022.104392. [PubMed:36434931].
5. Travers C, MacAndrew M, Hines S, O'Reilly M, Fielding E, Beattie E, et al. The effectiveness of meaningful occupation interventions for people living with dementia in residential aged care: a systematic review protocol. *JBI Database System Rev Implement Rep*. 2015;**13** (4):87-99. doi:10.11124/jbisrir-2015-2058. [PubMed:26447075].
6. Bennett S, Laver K, Voigt-Radloff S, Letts L, Clemson L, Graff M, et al. Occupational therapy for people with dementia and their family carers provided at home: a systematic review and meta-analysis. *BMJ open*. 2019;**9** (11):e026308-e. doi:10.1136/bmjopen-2018-026308. [PubMed:31719067].
7. Rostami HR, Akbarfahimi M, Ghaffari A, Kamali M, Rassafiani M. Relationship between Work-Related Quality of Life and Job Satisfaction in Iranian Occupational Therapists. *Occup Ther Int*. 2021;**2021**:6692752. doi:10.1155/2021/6692752. [PubMed:34629996].
8. Strong S, Rigby P, Stewart D, Law M, Letts L, Cooper B. Application of the Person-Environment-Occupation Model: a practical tool. *Can J Occup Ther*. 1999;**66** (3):122-33. doi:10.1177/000841749906600304. [PubMed:10462885].
9. Han A, Radel J, McDowd JM, Sabata D. Perspectives of People with Dementia About Meaningful Activities: A Synthesis. *Am J Alzheimers Dis Other Demen*. 2016;**31** (2):115-23. doi:10.1177/1533317515598857. [PubMed:26340962].
10. Kielsgaard K, Horghagen S, Nielsen D, Kristensen HK. Approaches to engaging people with dementia in meaningful occupations in institutional settings: A scoping review. *Scand J Occup Ther*. 2021;**28** (5):329-47. doi:10.1080/11038128.2020.1791952. [PubMed:32776817].
11. Ciro CA, Hershey LA, Garrison D. Enhanced task-oriented training in a person with dementia with Lewy bodies. *Am J Occup Ther*. 2013;**67** (5):556-63. doi:10.5014/ajot.2013.008227. [PubMed:23968794].
12. Hubbard IJ, Parsons MW, Neilson C, Carey LM. Task-specific training: evidence for and translation to clinical practice. *Occup Ther Int*. 2009;**16** (3-4):175-89. doi:10.1002/oti.275. [PubMed:19504501].
13. Ciro CA, Poole JL, Skipper B, Hershey LA. Comparing Differences in ADL Outcomes for the STOMP Intervention for Dementia in the Natural Home Environment Versus a Clinic Environment. *Austin Alzheimers Parkinsons Dis*. 2014;**1** (1). [PubMed:28261703].
14. Son BY, Bang YS, Hwang MJ, Oh EJ. Effect of task-oriented activities on hand functions, cognitive functions and self-expression of elderly patients with dementia. *J Phys Ther Sci*. 2017;**29** (8):1357-62. doi:10.1589/jpts.29.1357. [PubMed:28878462].
15. Gbiri CAO, Amusa BF. Progressive task-oriented circuit training for cognition, physical functioning and societal participation in individuals with dementia. *Physiother Res Int*. 2020;**25** (4):e1866. doi:10.1002/pri.1866. [PubMed:32776698].
16. Arevalo-Rodriguez I, Smailagic N, Roqué I Figuls M, Ciapponi A, Sanchez-Perez E, Giannakou A, et al. Mini-Mental State Examination (MMSE) for the detection of Alzheimer's disease and other dementias in people with mild cognitive impairment (MCI). *The Cochrane database of systematic reviews*. 2015;**2015** (3):CD010783-CD. doi:10.1002/14651858.CD010783.pub2. [PubMed:25740785].
17. Dehghanizadeh M, Akbarfahimi M, Zareiyan A, Khalafbeigi M, Soleimani F. Research Paper: Predictors of Interest in Performing Activities Among Iranian Adolescents with Cerebral Palsy. *Iranian Rehabilitation Journal*. 2020;**18** (4):377-85.
18. Hormozi S, Alizadeh-Khoei M, Sharifi F, Taati F, Aminalroaya

R, Fadaee S, et al. Iranian Version of Barthel Index: Validity and Reliability in Outpatients' Elderly. *International Journal of Preventive Medicine*. 2019;**10**:130. doi:10.4103/ijpvm.IJPVM_579_18.
19. Bruno D, Schurmann Vignaga S. Addenbrooke's cognitive examination III in the diagnosis of dementia: a critical review. *Neuropsychiatr Dis Treat*. 2019;**15**:441-7. doi:10.2147/NDT.S151253. [PubMed:30858702].
20. Christopher A, Kraft E, Olenick H, Kiesling R, Doty A. The reliability and validity of the Timed Up and Go as a clinical tool in individuals with and without disabilities across a lifespan: a systematic review. *Disabil Rehabil*. 2019:1-15. doi:10.1080/09638288.2019.1682066. [PubMed:31656104].
21. Chan WLS, Pin TW. Reliability, validity and minimal detectable change of 2-minute walk test, 6-minute walk test and 10-meter walk test in frail older adults with dementia. *Exp Gerontol*. 2019;**115**:9-18. doi:10.1016/j.exger.2018.11.001. [PubMed:30423359].
22. Salavati M, Negahban H, Mazaheri M, Soleimanifar M, Hadadi M, Sefiddashti L, et al. The Persian version of the Berg Balance Scale: inter and intra-rater reliability and construct validity in elderly adults. *Disabil Rehabil*. 2012;**34** (20):1695-8. doi:10.3109/09638288.2012.660604. [PubMed:22380626].
23. Aberson CL. *Applied power analysis for the behavioral sciences*. Routledge; 2019.
24. Booth V, Harwood RH, Hood-Moore V, Bramley T, Hancox JE, Robertson K, et al. Promoting activity, independence and stability in early dementia and mild cognitive impairment (PrAISED): development of an intervention for people with mild cognitive impairment and dementia. *Clin Rehabil*. 2018;**32** (7):855-64. doi:10.1177/0269215518758149. [PubMed:29436253].
25. Willey JZ, Moon YP, Kulick ER, Cheung YK, Wright CB, Sacco RL, et al. Physical Inactivity Predicts Slow Gait Speed in an Elderly Multi-Ethnic Cohort Study: The Northern Manhattan Study. *Neuroepidemiology*. 2017;**49** (1-2):24-30. doi:10.1159/000479695. [PubMed:28810247].
26. Zhang W, Low LF, Schwenk M, Mills N, Gwynn JD, Clemson L. Review of Gait, Cognition, and Fall Risks with Implications for Fall Prevention in Older Adults with Dementia. *Dement Geriatr Cogn Disord*. 2019;**48** (1-2):17-29. doi:10.1159/000504340. [PubMed:31743907].
27. Farajzadeh A, Akbarfahimi M, Maroufizadeh S, Miri Lavasani N. Factors Associated with Quality of Life among Caregivers of People with Spinal Cord Injury. *Occup Ther Int*. 2021:9921710. doi:10.1155/2021/9921710. [PubMed:34729057].

JRSR 11 (2024) 109-116

Journal of Rehabilitation Sciences and Research

Journal Home Page: jrsr.sums.ac.ir

Original Article

Effect of Eight Weeks of Combined Turning Exercises on the Performance of Female Educable Students with Down Syndrome: A Clinical Trial

Negar Heidari[1], MSc; Gholamali Ghasemi[1]*, PhD; Morteza Sadeghi[1], PhD; Negin Ghasemi Kahrizsangi[2], MD

[1]Department of Sport Injuries and Corrective Exercise, Faculty of Sport Sciences, University of Isfahan, Isfahan, Iran
[2]Isfahan University of Medical Sciences, Isfahan, Iran

ARTICLE INFO

Article History:
Received: 17/05/2023
Revised: 18/06/2023
Accepted: 29/08/2023

Keywords:
Down syndrome
Muscle strength
Student
Turning exercises

Please cite this article as:
Heidari N, Ghasemi GA, Sadeghi M, Ghasemi Kahrizsangi N. Effect of Eight Weeks of Combined Turning Exercises on the Performance of Female Educable Students with Down Syndrome: A Clinical Trial. JRSR. 2024;11(2):109-116. doi: 10.30476/JRSR.2023.98915.1373.

ABSTRACT

Background: The present study focuses on elucidating the effects of an eight-week combined turning exercise program on the physical performance of female students with Down syndrome (DS), a genetic disorder characterized by intellectual disability and often associated with weaker muscle strength. Individuals with DS typically exhibit reduced muscle strength due to a lower percentage of slow-twitch muscle fibers and a diminished overall number of muscle fibers.

Methods: In this semi-experimental clinical trial, the authors used purposive sampling to enroll 26 female students diagnosed with DS. Participants were randomly divided into an experimental group (n=13; mean age: 12.15±1.62 years, mean height: 139.23±8.94 cm, mean weight: 42.62±13.44 kg, mean IQ: 63.02±5.54) and a control group (n=13; mean age: 12.23±1.53 years, mean height: 141.15±10.31 cm, mean weight: 45.46±15.94 kg, mean IQ: 63.05±5.49). The authors evaluated muscle strength using a hand-held digital dynamometer, push-up test, long jump, and sit-up before and after the eight-week training period. The experimental group underwent a combined turning training program lasting 45-60 minutes daily, thrice a week, for eight weeks. We analyzed the data using repeated measures analysis of variance (ANOVA) with a significance level set at P≤0.05.

Results: The findings revealed a significant enhancement in physical performance among participants in the experimental group compared to those in the control group (P≤0.05). Specifically, the combined turning exercise program positively influenced upper body, middle body, and lower body muscle strength in female students diagnosed with DS.

Conclusion: The results of this investigation imply that incorporating combined turning exercises could serve as an effective strategy for enhancing muscle strength among female students diagnosed with DS. Integrating these exercises into rehabilitation programs tailored for individuals with DS may improve their physical performance and enhance their overall quality of life.

Introduction

Down syndrome (DS), a prevalent genetic disorder occurring in approximately 1 in 800-1200 live births [1], affects a considerable number of individuals worldwide, with over 200,000 people living with this condition in the United States alone [2] with 5000 additional children with DS born annually. Trisomy 21, accounting for about 95% of DS cases, underlies most syndrome instances. DS presents various medical challenges, including intellectual disabilities, cardiac anomalies, and respiratory complications [3]. Individuals with DS exhibit distinct

*Corresponding author: Gholamali Ghasemi, PhD; Department of Sport Injuries and Corrective Exercise, Faculty of Sport Sciences, University of Isfahan, Isfahan, Iran. **Tel:** +98 9131299817;
Email: gh.ghasemi@spr.ui.ac.ir

anatomical and physiological traits, distinguishing them from the general population [3, 4]. This paper investigates the implications of muscle weakness in DS individuals and the potential role of physical activity in enhancing muscle strength within this demographic.

Children with DS often demonstrate weaker muscle strength, slower speed, and inferior static and dynamic balance compared to typically developing children of the same age. These motor skill deficiencies are attributed to factors such as ligamentous laxity and low muscle tone, which are prevalent in individuals with DS. The weaker muscle strength observed in this population can be attributed to various factors, including a lower percentage of slow-twitch muscle fibers and a reduced number of muscle fibers. Consequently, individuals with DS are at a heightened risk of falls due to poor balance and lower limb muscle weakness. Furthermore, muscle weakness and hypotonia, particularly in the lower limbs, can impede overall physical health and the performance of daily activities. Research indicates that individuals with DS exhibit lower levels of muscle strength development compared to their healthy counterparts. However, engaging in physical activity has been shown to significantly enhance muscle strength in individuals with DS, underscoring its importance in improving physical health and overall quality of life in this population.

Children with DS often demonstrate weaker muscle strength, slower speed, inferior static and dynamic balance, lower visual control, as well as limited fine and gross motor skills compared to typically developing children of the same age [5]. These motor skill deficiencies are attributed to factors such as ligamentous laxity and low muscle tone, which are prevalent in individuals with DS [6]. The weaker muscle strength observed in this population can be attributed to various factors, including a lower percentage of slow-twitch muscle fibers and a reduced number of muscle fibers. Consequently, individuals with DS are at a heightened risk of falls due to poor balance and lower limb muscle weakness [7]. Furthermore, muscle weakness and hypotonia, particularly in the lower limbs, can impede overall physical health and the performance of daily activities [8]. Research indicates that individuals with DS exhibit lower levels of muscle strength development compared to their healthy counterparts [9]. However, engaging in physical activity has been shown to significantly enhance muscle strength in individuals with DS, compared to those with other intellectual disabilities [10], underscoring its importance in improving physical health and overall quality of life in this population.

Engaging in physical activity plays a vital role in mitigating health issues associated with sedentary behavior and physical inactivity, both of which are prevalent among individuals with DS [11]. For individuals with intellectual disabilities, maintaining an independent lifestyle is paramount, and physical activity serves as a cornerstone for achieving this goal. It offers an avenue for individuals to partake in physical training, fostering an active and self-sufficient life as they transition into adulthood. Thus, integrating physical activity into daily routines is indispensable for promoting health and well-being in this population [12]. Numerous studies have underscored the efficacy of various exercises and physical activities in enhancing physical fitness parameters among individuals with DS. Activities such as swimming [13], exercise therapy [14], trampoline exercises [15], and strength and balance training [16] have been shown to bolster aerobic capacity, muscle strength, balance, flexibility, body composition, and motor skills in this population. Additionally, research supports the benefits of a combined training regimen in improving motor performance, balance, and muscle strength among individuals with DS [17].

Turning exercises involve rotations around one or more axes, vertically or horizontally, at various joints or throughout the entire body. These exercises come in diverse forms and methods, including pivot exercises, twisting movements, swinging actions, directional changes, and multi-planar activities. They can target specific body parts such as the shoulders, hips, and core or involve the entire body. Turning exercises can be standalone or integrated with other training objectives, such as enhancing balance, strength, or core stability.

Executed across different axes, turning exercises demand coordination among various body systems and structures, leading to rapid improvements. Their multi-planar nature, involving movements in multiple directions, renders them more challenging and impactful than conventional exercises. Moreover, their resemblance to everyday movement patterns enhances their practical applicability [18].

Studies suggest that multi-plane exercises, like turning movements, offer superior benefits in neuromuscular integration, stability, and functional transfer compared to linear or single-plane exercises [19]. Furthermore, the complexity of turning exercises stimulates brain activation, enhances muscle coordination, and promotes cortical reorganization, ultimately improving overall performance [20].

The primary objective of this study was to assess the impact of an eight-week regimen of combined turning exercises on the physical performance of educable students diagnosed with DS. Given the adaptable nature of turning exercises, they present a promising avenue for the rehabilitation and physical conditioning of individuals with DS. Despite the potential benefits, there is a notable gap in the existing literature regarding the effects of combined turning exercises specifically tailored for individuals with DS.

Methods

This study employed a controlled clinical trial with a two-group design, comprising an experimental group subjected to turning training and a control group without such intervention. The research followed a pre-test and post-test assessment protocol. Ethical approval for the study was obtained from the Isfahan University ethics committee under the code of ethics IR.UI.REC.1401.043. The target population encompassed all female students aged 9 to 14 diagnosed with DS in Isfahan. Utilizing G-Power software, a sample size of 26 participants was

determined, achieving a power of 0.8. Participants were randomly paired based on IQ scores and subsequently allocated into two groups, each consisting of 13 individuals: an experimental group and a control group.

Before commencing the study, written consent was obtained from the participants' parents. Participants underwent an evaluation based on demographic characteristics and physical health status, which included age, IQ, height, weight, and cardiovascular and pulmonary health. All participants were deemed physically healthy, with IQs ranging from 50 to 70. Inclusion criteria for the study encompassed individuals identified as educable mentally disabled individuals with DS, as diagnosed by a physician, with an IQ falling within the range of 50 to 70. Additionally, participants were required to exhibit no signs of sexual maturity, absence of other disabilities or special diseases, and obtain consent from both parents and the participants to participate in the study. Exit criteria involved several conditions: absence from over 30% of training sessions for experimental group participants, voluntary withdrawal from the study, the occurrence of unforeseen problems hindering participation, or failure to complete research tests. Notably, all 26 participants completed the study.

Muscle strength was assessed utilizing a handheld digital dynamometer (manufactured by j-Teck, America) (Figure 1). The reliability and validity of this dynamometer have been extensively demonstrated across various studies, yielding intragroup correlation coefficients of 0.94 [21] and a range of correlation coefficients from 0.40 to 0.71 [22].

Muscle strength was assessed following the instructions provided by the device. For the limb muscle groups, muscle strength assessment was conducted using a break test at the mid-range of the muscle length (Figure 2). To evaluate the strength of the elbow flexor muscles, participants were seated comfortably with their elbows flexed at 90 degrees. The dynamometer was positioned on the end of the forearm in supination, and the strength of this muscle group was measured. Similarly, to assess the strength of the elbow extensor muscles, participants were seated with their elbows flexed at 90 degrees. The dynamometer was placed on the end of the forearm in pronation, and the strength of this muscle group was measured.

To assess the strength of the hip extensor muscles, participants were positioned on all fours, and the dynamometer was placed on the end of the femur. The strength of this muscle group was then measured.

Figure 1: Handheld digital dynamometer

Participants were placed on their side for the hip abductor muscles, and the dynamometer was positioned on the lateral condyle of the femur to measure the strength of this muscle group. Participants lay on their stomachs to evaluate the strength of the knee flexor muscles, and the dynamometer was placed on the end of the calf to measure the strength of this muscle group.

To evaluate the strength of the trunk flexor muscles, participants lay completely on their back, and the dynamometer was positioned on the chest. Participants then raised their heads and trunks to an angle of 45 degrees against resistance, and the strength of this muscle group was measured. Participants were placed on their stomachs for the trunk extensor muscles, and the lower body was secured to the bed. The dynamometer was placed between the scapulae. Participants raised their heads and trunks to an angle of 15 degrees against resistance, and the strength of this muscle group was measured. Each muscle group's strength was assessed three times, and the average of the three repetitions was recorded as the final score [23]. The tester applied sufficient force to overcome the resistance the subjects in each muscle group provided.

This study assessed muscle strength using the Bruininks-Oseretsky Test of Motor Proficiency strength sub-test, abbreviated as the BOT-2. The BOT-2 is a norm-referenced assessment tool designed to evaluate motor performance in children aged 4.5 to 14.5 years. It comprises eight sub-tests, encompassing 46 individual tasks [24]. However, only the strength sub-test was utilized for this study to measure muscle strength.

In the strength sub-test of the Bruininks-Oseretsky Test of Motor Proficiency, there were three components: the long jump test, the sit-up test, and the push-up test. Participants were directed to pull their arms back and leap forward as far as possible for the long jump test. They were encouraged to attempt to fall forward if balance

Figure 2: Some of the measuring the muscle strength

was lost during the jump. Each participant performed the test thrice, and the distance jumped on each occasion was recorded as their score (Figure 3) [24].

For the sit-up test, participants were instructed to lie on a mat with their hands placed on their femurs and their chin resting on their chest. An examiner positioned next to the participant placed a ruler on their knees. Participants were then asked to raise their trunks sufficiently to touch the ruler and return to the mat. The objective was to perform as many sit-ups as possible within a 20-second. Sit-ups executed with elbows on the floor, holding onto the mat or pants, or without touching the ruler were deemed incorrect and were not tallied. The total number of correct sit-ups completed by the participant within the allotted time was recorded as their score (Figure 4).

For the push-up test, participants assumed a prone position on a mat with their knees bent and in contact with a wall. Placing their hands next to their shoulders on the floor, participants were instructed to straighten their elbows fully, ensuring that their backs touched a ruler positioned by an examiner. They then lowered their chests to the ground, performing push-ups for 20 seconds. Push-ups were deemed incorrect if the participant's back arched and did not touch the ruler or if their hips rose above body level. The total number of correct push-ups completed within the allotted time was recorded as their score (Figure 5) [24].

After the pre-test, participants in the experimental group engaged in 8 weeks of combined turning exercises [25], with sessions lasting 45 to 60 minutes per day, conducted three times a week. Meanwhile, the control group maintained their regular activities throughout the study period. The exercises were structured according to the overload, progression, and individualization principles (Table 1).

The Shapiro-Wilk test was employed to assess the normality of data distribution. Descriptive statistics, such as mean and standard deviation, were utilized to summarize the data. Repeated measures analysis of variance (ANOVA) was employed for inferential statistics, with significance set at 0.05.

Results

The results are summarized in Tables 2 and 3. Table 2 presents the demographic characteristics of the participants, encompassing height, weight, age, and IQ.

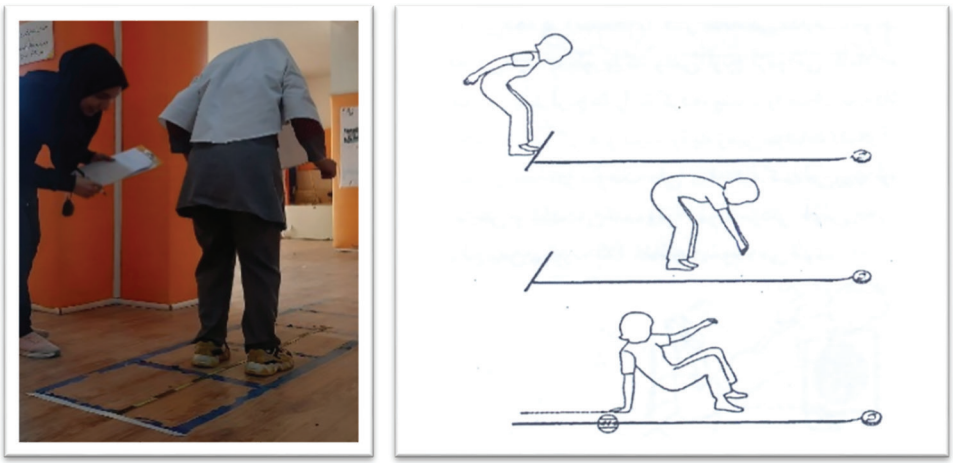

Figure 3: Long jump

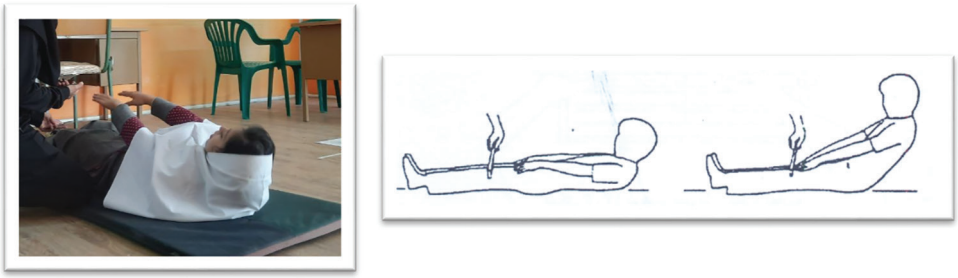

Figure 4: Sit-up test

Figure 5: Push-up test

Table 1: Overview of the exercise program in the experimental group

The combined turning exercises		
Warm-up	Low-intensity aerobic exercises and range of motion (ROM)exercises	10 minutes
Resistance turning exercises	Upper limbs: chest, back, shoulder, forearm, back of arm, etc. Core stability: sit-up, bridge, plank, superman, vacuum, etc. Lower limbs: hip flexion, hip abduction, hip adduction, knee flexion, knee extension, lifting on the toe, squat, etc.	20 minutes
Standing turning exercises	1. Standing on two feet, anterior cross standing, posterior cross standing, standing heel to heel, standing on both feet and turning the head, standing on both feet and turning the trunk, standing on both feet and turning lumbar, standing on both feet and turning weight transfer, standing and turning upper body with open arms, standing on one leg, Standing with one leg turned outward, standing on one leg and turning the head, standing on one leg and turning the trunk, standing on one leg and turning lumbar, standing on one leg and turning weight transfer, standing and turning the lateral pair of feet on the heel, standing and turning the lateral pair of feet on the forefoot, toe raises internal rotation and external rotation, standing and turning one leg around the other 2. Rotate 180 degrees, rotate 270 degrees, single leg stance-clock, 90 degrees, turning the jump pair of legs and one leg, etc.	25 minutes
Walking turning exercises	Exercises in turning paths: walking, walking to the side, narrow walking, march walking, semi-tandem walking, walking on toes, tandem walking, semi-tandem walking on toes, tightrope walking, galloping, sliding, hopping, lateral walking on heel and toe, cross walking, braiding walking, dynamic walking, walking and turning the ball around the lumbar, walking backward, grapevine walking, etc.	
Cool down	Low-intensity aerobic exercises and range of motion (ROM)exercises	5 minutes

Table 2: The demographic characteristics of the participants

Factor	Group	Mean±SD	t	P
Age	Experimental	12.15±1.62	0.9	0.6
	Control	12.23±1.53		
Height	Experimental	139.23±8.94	1.1	0.1
	Control	141.15±10.31		
Weight	Experimental	42.62±13.44	1.7	0.08
	Control	45.46±15.94		
IQ	Experimental	63.02±5.54	0.85	0.7
	Control	63.05±5.49		

SD: Standard deviation; IQ: Inteligence quotient

None of the measurement factors yielded significant P values ($P<0.05$), indicating homogeneity between the groups across demographic characteristics, particularly mental performance.

Table 3 presents both descriptive statistics and the variance analysis results. The interaction term in the repeated measures analysis of variance is particularly noteworthy as it reflects the changes between the two groups over time, thereby delineating the progression. The analysis indicated a significant interaction effect for muscle strength ($P<0.05$), signifying that the changes observed in the experimental group exceeded those in the control group, with the experimental group demonstrating greater improvement.

Discussion

This study aimed to assess the impact of an eight-week combined turning exercise program on the physical performance of educable students with DS. The findings revealed a notable enhancement in muscle strength ($P<0.05$), suggesting that combined turning exercises effectively augment muscle strength among students with DS.

The exercise regimen employed in this study included resistance-turning exercises specifically targeting the upper body muscles, including the chest, back, shoulders, forearms, and triceps. These exercises are instrumental in strengthening the connective tissues surrounding the elbows, shoulders, neck, spine, wrists, and hands, enhancing joint health and stability while mitigating the risk of injuries. As evidenced by the significant improvement observed in the push-up test, participants in the experimental group demonstrated enhanced upper-body muscle strength following the intervention.

Lower body exercises are pivotal in enhancing physical endurance and overall strength. By targeting the muscles of the lower body, individuals can fortify their core, enhance range of motion, and augment strength in various muscle groups. The combined turning exercises in this study engaged the lower body muscles comprehensively, leading to notable improvements in lower limb muscle strength. Additionally, participants in the experimental group exhibited significant enhancements in the long jump test.

The strength of the trunk muscles is paramount for generating force against external resistance encountered during daily activities, underscoring the importance of maintaining optimal trunk muscle strength for overall physical fitness and efficiency [26]. In this study, the exercise regimen incorporated resistance-turning exercises targeting the core muscles, thereby contributing to trunk flexor and extensor strength improvements. Notably, participants in the experimental group demonstrated a significant enhancement in trunk muscle strength, as evidenced by their improved performance in the sit-up test.

The lack of significant progress observed in the control group underscores the notable impact of combined turning exercises on enhancing the strength—both upper, lower, and mid-body—of students with DS.

Individuals with intellectual disabilities often face barriers to engaging in regular physical activity, which can contribute to declines in cardiovascular fitness,

Table 3: General results of analysis of variance for repeated measurements of muscle strength (handheld digital dynamometer, push-up, sit-up, and long jump)

Variable		Group	Pre-test Mean±SD	Post-test Mean±SD	Intragroup changes	Group interaction	Intergroup changes	η^2	Power
Elbow flexor muscles (Newton)	Right	Experimental	39.09±20.48	65.64±25.96	F=43.50 P=0.00	F=31.20 P=0.00	F=2.89 P=0.1	0.565	1
		Control	38.58±14.13	40.74±16.55					
	Left	Experimental	47.03±22.18	68.63±29.41	F=40.60 P=0.00	F=18.80 P=0.00	F=5.41 P=0.02	0.439	0.986
		Control	37.73±10.65	41.84±14.03					
Elbow extensor muscles (Newton)	Right	Experimental	39.02±18.01	53.47±21.95	F=39.28 P=0.00	F=31.04 P=0.00	F=3.57 P=0.07	0.546	1
		Control	33.84±13.18	34.69±10.36					
	Left	Experimental	34.35±16.15	35.95±23.36	F=34.67 P=0.00	F=25.39 P=0.00	F=3.28 P=0.08	0.514	0.998
		Control	32.15±12.59	33.67±10.90					
Arm adductor muscles (Newton)	Right	Experimental	27.41±9.09	33.98±7.20	F=62.36 P=0.00	F=28.16 P=0.00	F=0.35 P=0.55	0.54	0.999
		Control	28.75±12.85	30.63±13.12					
	Left	Experimental	26.73±8.22	35.20±9.33	F=76.81 P=0.00	F=26.49 P=0.00	F=0.02 P=0.88	0.525	0.999
		Control	29.27±10.97	31.47±12.61					
Arm abductor muscles (Newton)	Right	Experimental	27.75±8.77	42.30±14.87	F=27.76 P=0.00	F=9.74 P=0.00	F=3.18 P=0.08	0.289	0.85
		Control	26.23±7.26	29.95±10.98					
	Left	Experimental	26.40±7.82	41.46±14.50	F=28.09 P=0.00	F=17.89 P=0.00	F=4.78 P=0.03	0.427	0.982
		Control	25.55±7.38	27.24±6.87					
Hip flexor muscles (Newton)	Right	Experimental	69.64±28.38	112.32±41.70	F=26.95 P=0.00	F=20.60 P=0.00	F=5.82 P=0.02	0.462	0.992
		Control	62.40±26.66	65.26±23.13					
	Left	Experimental	56.84±23.21	99.13±33.90	F=33.43 P=0.00	F=26.63 P=0.00	F=3.90 P=0.06	0.526	0.999
		Control	57.50±23.25	59.90±25.19					
Hip extensor muscles (Newton)	Right	Experimental	48.21±19.66	75.24±26.71	F=76.12 P=0.00	F=48.41 P=0.00	F=6.93 P=0.01	0.669	1
		Control	41.63±10.94	44.76±12.29					
	Left	Experimental	46.35±21.37	70.07±26.96	F=43.92 P=0.00	F=41.59 P=0.00	F=6.95 P=0.01	0.634	1
		Control	39.60±10.55	39.92±11.52					
Hip abductor muscles (Newton)	Right	Experimental	42.98±19.02	68.47±27.44	F=96.67 P=0.00	F=46.83 P=0.00	F=5.42 P=0.02	0.661	1
		Control	36.04±12.71	40.61±15.28					
	left	Experimental	38.92±14.35	71.01±35.34	F=26.08 P=0.00	F=11.57 P=0.00	F=6.78 P=0.01	0.325	0.904
		Control	32.32±10.60	38.75±15.77					
Knee flexor muscles (Newton)	Right	Experimental	43.66±18.29	67.78±28.16	F=37.32 P=0.00	F=21.54 P=0.00	F=4.56 P=0.04	0.473	0.994
		Control	39.09±10.59	42.38±13.03					
	left	Experimental	43.21±21.90	65.27±36.03	F=29.09 P=0.00	F=14.71 P=0.00	F=3.09 P=0.09	0.38	0.957
		Control	37.56±10.25	41.29±10.51					
Trunk extensor muscles (Newton)		Experimental	51.44±18.35	77.81±23.88	F=86.06 P=0.00	F=51.48 P=0.00	F=5.37 P=0.02	0.682	1
		Control	45.87±16.85	49.24±16.88					
Trunk flexor muscles (Newton)		Experimental	43.83±17.19	65.66±19.83	F=42.91 P=0.00	F=22.45 P=0.00	F=9.04 P=0.00	0.481	0.995
		Control	36.21±9.98	39.76±10.75					
Push-up (Second)		Experimental	1±0.91	7.46±2.72	F=126.42 P=0.00	F=90.51 P=0.00	F=38.73 P=0.00	0.79	1
		Control	0.77±0.72	1.31±0.75					
Sit-up (Second)		Experimental	2.69±2.23	11.69±3.47	F=156 P=0.00	F=99.84 P=0.00	F=35.98 P=0.00	0.806	1
		Control	1.77±1.23	**2.77**±1.64					
Long jump (Centimeter)		Experimental	49.30±11.49	63.46±16.18	F=31.45 P=0.00	F=17.22 P=0.00	F=2.07 P=0.00	0.418	0.978
		Control	46.65±17.95	48.77±16.79					

Significance at $P \leq 0.05$. η^2: Partial eta squared

muscle strength, speed, and overall physical fitness levels [27]. Moreover, the inherent challenges associated with intellectual disabilities may predispose individuals to lower flexor and extensor strength and endurance levels in the trunk muscles. These deficits can adversely affect coordination during complex movements and impede this population's development of motor skills [28].

The utilization of turning exercises represents this study's significant and innovative aspect. Turning, an integral aspect of mobility [29] and daily activities [30], poses greater challenges than straightforward walking [31-34] and engages multiple limbs and joints. By incorporating turning components and multi-planar movements, turning exercises offer a more demanding and impactful training regimen than conventional exercises. Moreover, the resemblance of turning movements to daily movement patterns enhances their transferability to real-life scenarios [18].

Turning training necessitates coordination across various bodily systems and processes due to its complexity, requiring higher levels of sensory-motor integration and cognitive engagement. This multifaceted nature of turning exercises elicits greater compatibility and adaptive responses from training individuals [35]. Moreover, turning exercises demand intricate coordination of whole-body movements and the integration of multiple sensory systems to meet the heightened balance requirements [36].

Furthermore, turning exercises entail the complex control of trunk movements alongside asymmetric lower limb movements. Compared to straight walking, turning necessitates a series of neural processes to achieve

stability and regulate forward progress effectively [33]. Consequently, impairments in balance, postural stability, flexibility, strength, trunk mobility, and coordination can impact an individual's ability to perform turning movements effectively [37].

The research underscores the efficacy of multi-component exercise interventions in enhancing physical performance. Turning training, including turning components and multi-planar movements, is more effective than traditional training methods. The resemblance of turning movements to everyday movement patterns enhances their transferability, making them more applicable to real-life situations [18].

Multi-plane exercises, such as turning, have been associated with greater enhancements in neuromuscular integration, stability, and functional transfer compared to linear or single-plane movements [19]. The complexity of turning exercises physically and cognitively challenges individuals, promoting increased brain activation, muscle coordination, and cortical reorganization. These adaptations ultimately lead to improvements in overall physical performance [20].

The exercise regimen implemented in this study specifically targeted muscle strength enhancement, aiming to mitigate muscle hypotonia commonly observed in individuals with DS. In the experimental group, various multi-plane exercises were employed to train different muscle groups of the upper limbs, aligning with the muscles assessed in both the push-up test and the dynamometer's evaluations. These exercises encompassed the elbow flexors, extensors, abductors, and arm adductors. Consequently, significant improvements in upper body muscle strength were observed, as evidenced by the test progress and the significant interaction in this muscle group.

Furthermore, the resistance training program also focused on bolstering core stability by targeting the muscles associated with trunk flexion and extension, which were evaluated through the sit-up test and dynamometer assessments.

Hence, notable advancements were evident in the assessments, along with a notable enhancement in the strength of the core stability muscles. The third component of the multi-plane resistance exercises and turning routines targeted the lower extremities, engaging muscle groups assessed in the long jump test and those evaluated by the dynamometer (comprising hip flexors, hip extensors, hip adductors, and knee flexors). Consequently, improvements in the assessments and a significant enhancement in lower limb strength were apparent. These findings underscore the impact of combined turning exercises on muscle strength among students diagnosed with DS.

This study has several limitations, including a limited sample size exclusively comprising females, a lack of follow-up assessments after the post-test to ascertain the sustainability of the observed outcomes, and an absence of prior research exploring the effectiveness of turning exercises, hindering comparison and generalization. Consequently, future research should aim to include participants of both genders and incorporate long-term follow-up assessments to address these limitations comprehensively.

Conclusion

The findings revealed a notable enhancement in muscle strength ($p < 0.05$), suggesting that combined turning exercises effectively augment muscle strength among students with DS. The results of this investigation imply that incorporating combined turning exercises could serve as an effective strategy for enhancing muscle strength among female students diagnosed with DS. Integrating these exercises into rehabilitation programs tailored for individuals with DS may improve their physical performance and enhance their overall quality of life.

Acknowledgment

We would like to express our gratitude to Education Department of Isfahan Province, all the subjects and their families who helped us in conducting this study.

Conflict of Interest: None declared.

References

1. Torr J, Strydom A, Patti P, Jokinen N. Aging in Down syndrome: morbidity and mortality. Journal of Policy and Practice in Intellectual Disabilities. 2010;7(1):70-81.
2. Moore G, Durstine JL, Painter P, Medicine ACoS. Acsm's exercise management for persons with chronic diseases and disabilities, 4E: Human Kinetics; 2016.
3. Cabeza-Ruiz R, García-Massó X, Centeno-Prada R, Beas-Jiménez J, Colado J, González L-M. Time and frequency analysis of the static balance in young adults with Down syndrome. Gait & posture. 2011;33(1):23-8.
4. Wu J, Ulrich DA, Looper J, Tiernan CW, Angulo-Barroso RM. Strategy adoption and locomotor adjustment in obstacle clearance of newly walking toddlers with Down syndrome after different treadmill interventions. Experimental Brain Research. 2008;186(2):261-72.
5. El-Meniawy GH, Kamal HM, Elshemy SA. Role of treadmill training versus suspension therapy on balance in children with Down syndrome. Egyptian Journal of Medical Human Genetics. 2012;13(1):37-43.
6. Berg P, Becker T, Martian A, Danielle PK, Wingen J. Motor control outcomes following Nintendo Wii use by a child with Down syndrome. Pediatric Physical Therapy. 2012;24(1):78-84.
7. Bahiraei S, Daneshmandi H. The Study of relationship between structural profiles and postural control in individual with Down syndrome. Journal of Practical Studies of Biosciences in Sport. 2014;2(4):21-32.
8. Eid MA, Aly SM, Huneif MA, Ismail DK. Effect of isokinetic training on muscle strength and postural balance in children with Down's syndrome. International Journal of Rehabilitation Research. 2017;40(2):127-33.
9. Borji R, Zghal F, Zarrouk N, Sahli S, Rebai H. Individuals with intellectual disability have lower voluntary muscle activation level. Research in developmental disabilities. 2014;35(12):3574-81.
10. Yu C, Li J, Liu Y, Qin W, Li Y, Shu N, et al. White matter tract integrity and intelligence in patients with mental retardation and healthy adults. Neuroimage. 2008;40(4):1533-41.
11. Graham A, Reid G. Physical fitness of adults with an intellectual disability: A 13-year follow-up study. Research quarterly for exercise and sport. 2000;71(2):152-61.
12. Mashhadi M, Ghasemi G, Zolaktaf M. The Effect of selected exercise training on thoracic kyphosis and lumbar lordosis of adolescents with mental retardation. Journal of research rehabilitation. 2012;8(1):192-201.
13. Naczk A, Gajewska E, Naczk M. Effectiveness of swimming

program in adolescents with down syndrome. International journal of environmental research and public health. 2021;18(14):7441.
14. Barnard M, Swanepoel M, Ellapen TJ, Paul Y, Hammill HV. The health benefits of exercise therapy for patients with Down syndrome: A systematic review. African journal of disability. 2019;8(1):1-9.
15. Giagazoglou P, Kokaridas D, Sidiropoulou M, Patsiaouras A, Karra C, Neofotistou K. Effects of a trampoline exercise intervention on motor performance and balance ability of children with intellectual disabilities. Research in developmental disabilities. 2013;34(9):2701-7.
16. Gupta S, Rao BK, Kumaran S. Effect of strength and balance training in children with Down's syndrome: a randomized controlled trial. Clinical rehabilitation. 2011;25(5):425-32.
17. Bahiraei S, Daneshmandi H, Sedaghati P. The effect of a selective combined training program on motor performance, balance and muscle strength in boys with Down Syndrome (DS). Journal of Paramedical Sciences & Rehabilitation. 2017;6(4):40-5.
18. Jadczak AD, Makwana N, Luscombe-Marsh N, Visvanathan R, Schultz TJ. Effectiveness of exercise interventions on physical function in community-dwelling frail older people: an umbrella review of systematic reviews. JBI Evidence Synthesis. 2018;16(3):752-75.
19. Patel K, Wilkinson N. Corrective Exercise: A Practical Approach: A Practical Approach: Routledge; 2014.
20. Chen I-H, Yang Y-R, Chan R-C, Wang R-Y. Turning-based treadmill training improves turning performance and gait symmetry after stroke. Neurorehabilitation and neural repair. 2014;28(1):45-55.
21. Yousefi M, Eelbeigi S, Mehrshad N, Afzalpoor M. Detection of spinal abnormalities using markers mounted on the spine appendages. Sports medicine. 2011;4:73-89.
22. Bohannon R. Hand-held compared with isokinetic dynamometry for measurement of static knee extension torque (parallel reliability of dynamometers). Clinical Physics and Physiological Measurement. 1990;11(3):217.
23. Arnold CM, Warkentin KD, Chilibeck PD, Magnus CR. The reliability and validity of handheld dynamometry for the measurement of lower-extremity muscle strength in older adults. The Journal of Strength & Conditioning Research. 2010;24(3):815-24.
24. Bruininks RH, Bruininks BD. Bruininks-Oseretsky test of motor proficiency. 1978.
25. Ghaderian M, Ghasemi GA, Lenjannejadian S, Demneh ES. The Effect of Turning Training in Comparison with Balance Training on Balance Performance, Mobility, Turning and Fear of Falling in Older Adults1. Studies in Sport Medicine. 2022;14(32):43-76.
26. Arampatzis A, Frank J, Laube G, Mersmann F. Trunk muscle strength and lumbo-pelvic kinematics in adolescent athletes: Effects of age and sex. Scandinavian journal of medicine & science in sports. 2019;29(11):1691-8.
27. Hosseini-Kakhk SA, Nasrabadi S, Haghighi A-H, Sharifi-Moghadam A. The effect of combined exercise training program on some physical fitness factors in mentally retarded girls. Journal of Practical Studies of Biosciences in Sport. 2018;6(11):109-20.
28. Kong Z, Sze T-M, Yu JJ, Loprinzi PD, Xiao T, Yeung AS, et al. Tai Chi as an alternative exercise to improve physical fitness for children and adolescents with intellectual disability. International journal of environmental research and public health. 2019;16(7):1152.
29. Berg K, Wood-Dauphine S, Williams J, Gayton D. Measuring balance in the elderly: preliminary development of an instrument. Physiotherapy Canada. 1989;41(6):304-11.
30. Glaister BC, Bernatz GC, Klute GK, Orendurff MS. Video task analysis of turning during activities of daily living. Gait & posture. 2007;25(2):289-94.
31. Segal AD, Orendurff MS, Czerniecki JM, Shofer JB, Klute GK. Local dynamic stability in turning and straight-line gait. Journal of biomechanics. 2008;41(7):1486-93.
32. Courtine G, Schieppati M. Human walking along a curved path. I. Body trajectory, segment orientation and the effect of vision. European Journal of Neuroscience. 2003;18(1):177-90.
33. Orendurff MS, Segal AD, Berge JS, Flick KC, Spanier D, Klute GK. The kinematics and kinetics of turning: limb asymmetries associated with walking a circular path. Gait & posture. 2006;23(1):106-11.
34. Boelen MP. Health Professionals' Guide to Physical Management of Parkinson's Disease: Human Kinetics; 2009.
35. Brahms CM, Hortobágyi T, Kressig RW, Granacher U. The interaction between mobility status and exercise specificity in older adults. Exercise and sport sciences reviews. 2021;49(1):15-22.
36. Cheng F-Y, Yang Y-R, Wu Y-R, Cheng S-J, Wang R-Y. Effects of curved-walking training on curved-walking performance and freezing of gait in individuals with Parkinson's disease: a randomized controlled trial. Parkinsonism & related disorders. 2017;43:20-6.
37. Khobkhun F, Khacharoen S, Tretriluxana J, Richards J. The effectiveness of exercise on gait, turning and falls in individuals with Parkinson's disease: A Scoping Review. International Journal of Pharmaceutical Research. 2021;13(2).