Original Article

Health Related Fitness Physical Education Intervention: Self-Determination Perspective

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Abstract

Introduction: The purpose of this study was to investigate the effect of 8-week health-related physical education (HRFPE) intervention on 9th-grade students' health-related fitness knowledge (HRFK) level, physical activity level (PAL), and physical fitness levels. Methods: Experimental research with two groups, HRFPE, and skill-based physical education, with 154 students, was measured before and after the intervention. While the experimental group attended the HRFPE intervention, the comparison group attended the skill-based physical education intervention. Quantitative data were gathered from Health-Related Fitness Knowledge Test (HRFKT), International Physical Activity Questionnaire for Adolescents (IPAQ-A), and Fitnessgram tests (Left & right leg Flexibility, Push-up, Pacer, Curl-up, and BMI). Data gathered from HRFKT, and IPAQ-A were analyzed by mixed-design multivariate analysis of variance (MANOVA). Data from Fitnessgram tests were analyzed by mixed-design analysis of variance (ANOVA). Results: The knowledge test results revealed a significant effect of HRFPE intervention on students' cardiorespiratory fitness, muscular endurance, training principles, and general health knowledge parameters of HRFKT. The intervention significantly increased the low and vigorous PAL of participants. The HRFPE intervention positively affected right leg flexibility, pacer cardiovascular, curl-up muscular endurance, and BMI. Results demonstrated the effect of self-determination theory based HRFPE intervention on developing students' HRFK level, physical activity behavior, and physical fitness test performances. Conclusions: This study revealed that physical education teachers could design and implement HRFPE course interventions in real school settings. Further recommendations were discussed regarding the content and implementation of intervention for physical education teachers, curriculum specialists, and future studies.

Keywords: Experimental Study, Physical Activity Level, Physical Fitness, Physical Fitness Knowledge, Self-Determination Theory.

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INTRODUCTION

The global health surveys revealed that physically inactive lifestyles and consequences had been a concern in many countries (USDHHS, 2018; WHO, 2002). World Health Organization (2010) recommends 60 minutes of moderate to vigorous physical activity daily for 5-17 years of children and adolescents. Still, there has been a rapid decrease in Physical Activity (PA) levels and an increasingly sedentary lifestyle (Pate, 1993; Thomas, 2006). Behaviors that may pose a health risk are observed frequently at the beginning of high school, such as lack of physical activity, malnutrition and becoming overweight (Kann et al., 2018; D. Katz et al., 2021; Skinner, Ravanbakht, Skelton, Perrin, & Armstrong, 2018). Ages of 14-15, the 9th grade, are crucial since high levels of sit-outs in physical education (PE) classes and rapid dropouts in individual & team sports participation were observed (Fisette, 2011; West & Strand, 2016). Diversely individuals who have the habit of doing regular physical activity (PA) in childhood and adolescence may carry this behaviour to the following years and lead a healthier life (Cleland, Dwyer, & Venn, 2012; Rangel, Fellingham, Santana, & Lamas, 2022).

Increasing PA in society is complicated and influenced by physiological, psychological, sociocultural and ecological factors (Dobbins, Husson, DeCorby, & LaRocca, 2013). Physiological determinants of PA among adolescents involve gender, age, and ethnicity(Hudson, 2008; Sallis, Prochaska, & Taylor, 2000). Confidence in engaging PA perception of sport competence, positive attitude toward PA, enjoyment of PA, and perceived benefits from exercise are the psychological determinants of PA (Dishman et al., 2005; Sallis et al., 2000; Zakarian, Hovell, Hofstetter, Sallis, & Keating, 1994). Sociocultural influences include family or peer support (Adkins, Sherwood, Story, & Davis, 2004) , and ecological determinants of PA refer to access to playgrounds and facilities (DiLorenzo, Stucky-Ropp, Vander Wal, & Gotham, 1998). These studies contain

guiding information highlighting the reconstruction of education and social health policies.

Schools are important places that provide direct access to the majority of the children and young population and have facilities, teachers, and curriculum to achieve educational health objectives (Dobbins et al., 2013; Hills, Dengel, & Lubans, 2015). PE programs aim to help students gain and advance the necessary knowledge, skills, and attitudes to maintain a physically active and healthy lifestyle (McKenzie & Lounsbery, 2014) . However, traditional sport-related PE has had limited achievement in promoting this aim in children and adolescent populations (Dale, Corbin, & Cuddihy, 1998; Ortega, Ruiz, Castillo, & Sjöström, 2008). The efficiency of PE courses in terms of gaining positive health behaviour habits needs to be modified through the Health-Related Fitness Physical Education (HRFPE) to fulfil the needs of students. Self-Determination Theory (SDT) has been adapted to various social science, including sports, exercise and PE (Deci & Ryan, 2013). According to SDT principles, social-contextual dynamics can affect individuals' motivation by fulfilling three primary necessities: autonomy, competence, and relatedness. HRFPE program that is prepared according to SDT principles overlaps considerably on the completion of four factors, which are affecting physical activity behavior in early years.

When the HRFPE curriculum was designed according to strategies that satisfy these three psychological needs of the SDT, the following positive affective attitudes such as interest, curiosity, care, and abiding values were observed in studies (Langdon, Webster, Hall, & Monsma, 2014; Ntoumanis & Standage, 2009; Shen, 2014). Students value participation in PE courses because HRFPE provides a high level of effort, enjoyment, cooperative learning, passion, and creativity and helps sustain intrinsic motivation as well (Jaakkola, Wang, Soini, & Liukkonen, 2015; Karagiannidis, Barkoukis, Gourgoulis, Kosta, & Antoniou, 2015). Besides, PE programs have placed greater emphasis on five components of HRF, namely cardiorespiratory fitness, flexibility, muscular strength, muscular endurance & body composition, which necessitate fitness assessment tests, goal setting, and submission for each component of HRF and total health. Therefore, SDT based HRFPE focuses on the knowledge, skills, and attitudes required to promote health and well-being to encourage active lifestyles. The benefits of HRFPE have been observed in PA, physical fitness, academic, social, and psychological levels (Le Masurier & Corbin, 2006; Standage, Gillison, Ntoumanis, & Treasure, 2012).

This study searches whether the implication of SDT-based HRFPE courses will verify the following hypotheses: HRFPE intervention may be more effective on students' "Health Related Fitness" knowledge, physical activity, and physical fitness levels. SDT-based HRFPE course concept in Turkey has been chiefly applied in university settings. However. There has been limited study focusing on the knowledge level of HRFPE. At that point, this study could bring a new aspect to the understanding of 9th-grade physical education.

METHODS

An experimental study with a comparison group was designed to measure the effect of HRFPE intervention. The experimental group was given cardiovascular endurance, muscular endurance, flexibility, body weight management, and general evaluation subjects (health standards, intensity of physical activity). In contrast, the comparison group studied basketball, volleyball, and gymnastics in Skill-Related Physical Education during an 8-week intervention period.

Ethical Clearance

Permission to conduct the study started with the approval of the Human Subjects Ethics Committee at Middle East Technical University (ethical clearance number 28620816/165-318) in accordance with the Declaration of Helsinki. Afterwards, permission was obtained from the TED Ankara College High School principal and general director, where the participants were students (TEDANK-L-900.01/224). Participants were given an informed consent form declaring privacy sentences, voluntarily participation, and anytime withdrawal without reason, to be signed by their parents.

Participants and Design

This study was conducted with 154 (90 females & 64 males) 9th-grade students with a mean age of 14.6 and between the ages of 14-15. Participants were allocated randomly into either the experimental group N=72 (27 male & 45 female HRFPE group) or the comparison group N=82 (37 male & 45 female skill-related physical education group). The overall study design is given in Figure 1.

Figure 1: Overall study design

Time		2 Weeks	8 Weeks Intervention				2 Weeks
Groups	N	Pre-Test	1st-2nd Week	3rd-4th Week	5th-6th Week	7th-8th Week	Post-Test
Experimental Group	72	HRF Knowledge Test IPA Questionnaire Fitnessgram Test	Cardio Respiratory Fitness	Muscular Strength & Endurance	Muscular Flexibility	BMI & Weight Control	HRF Knowledge Test IPA Questionnaire Fitnessgram Test
Comparison Group	82	Skill-Related Physical Education Program (Basketball, Volleyball, Gymnastics)					

Intervention and Measurements

Two weeks before and after the intervention, 9th-grade students in both the experimental and the comparison groups completed the HRF Knowledge Test with 36 items. International Physical Activity Questionnaire for Adolescents (IPAQ-A), and Fitnessgram tests. At the beginning of each hour in the experimental group, students first expressed and discussed their HRF experiences and then performed previously designed activities with which students could exhibit choice, feel competent, and interact with others. Expected learning outcomes and SDT-based instructions are presented in Table 1.

Table 1: Instructional Goals and Sample Activities

Principles	Goals & Sample Activities
Autonomous	Operating and interpreting health-related fitness test scores Checking personal physical activity on questionnaires Heart rate monitor watch, pedometer measurements Selecting appropriate physical fitness activity Diaries, interest inventories Interpreting health-related fitness test scores Studying personal health-related fitness necessities Searching for positive and fun activities based on personal interests and needs
Competence	Goal setting & applying for each health-related fitness characteristic based on the fitness test Goal setting and applying for each health-related fitness characteristic based on the PA level Goal setting for each health-related fitness characteristic based on the fitness test Practising appropriate exercise mode, intensity, and frequency
Relatedness	Observing family members' health-related behaviours Discussion of the value of physical activity in personal well-being Group discussion about well-being and sharing personal experiences. Participating in positive, fun activities Participating in physical activities with friends and family members Participating in positive, fun activities

The Health-Related Fitness Knowledge Test (HRFKT)

The HRF Knowledge Test for Middle School Students was developed by Mott, Warren, Virgilio, and Berenson, (1991) to measure elementary and middle

school children's knowledge of HRF concepts. The instrument was translated into Turkish and validated in a series of studies by Hünük and İnce (2010) for Turkish post-primary school students. There were 25 items in the original questionnaire, and the researchers added 11 items. The final version of the questionnaire was a 36-item multiple-choice paper-pencil test, and it is composed of cardiovascular endurance, muscular strength, muscular endurance, flexibility, body composition, training principles, and general health knowledge sub-scales. The internal, external, and construct validity were satisfied, and reliability was calculated as KR-20=0.74 for this study.

International Physical Activity Questionnaire for Adolescents (IPAQ-A)

The International Physical Activity Questionnaire for Adolescents (IPAQ-A; (Craig et al., 2003), which is used to determine the participants' physical activity (PA) level, evaluates the frequency, duration and severity of physical activity performed in the last seven days. The metabolic equivalent (MET) calculation specified in the directive of the IPA questionnaire (IPAQ-A. 2005) can be performed. According to the calculated MET values, the weekly physical activity level of individuals can be classified as low (600 MET and below), medium (601-3000 MET), and high level (3001 & above MET). Saglam et al., (2010) adapted the Turkish version of this questionnaire.

Health Related Physical Fitness-Fitnessgram

Fitnessgram is a complete educational, recording, and the persuasive instrument used for evaluating children's physical fitness and physical activity levels with different tests. The reliability and validity of its fitness tests were checked (Buono, Roby, Micale, Sallis, & Shepard, 1991; Marshall, Sarkin, Sallis, & Mckenzie, 1998). The assessment includes a variety of health-related physical fitness tests that are used to determine students' physical fitness and advise progressive zones for enhancement of aerobic capacity (pacer test), muscular strength (push up), muscular endurance (curl up), flexibility (sit and reach), and body composition (BMI).

Data Analysis

Before the study, G-Power analysis software was used to determine the study's required sample size. The analysis was conducted for mixed-design ANOVA for two groups and for considering the 8 dependent variables (HRF knowledge level, PA level, right leg flexibility level, left leg flexibility level, push-up level, pacer level, curl-up level & body mass index level) of the study. The result of the analysis displayed that the total sample size required for the study was 138, with .951 actual power. The total sample size was 152, which is enough to conduct the study (Tabachnick & Fidell, 2000).

Descriptive statistics for explanatory information were assessed. A mixed-design multivariate analysis of variance (MANOVA) was conducted to analyze reasonable differences in the measures of HRFKT and IPAQ-A from pre to post-tests. However, mixed-design analysis of variance (ANOVA) was conducted to see the effect of Health-Related Fitness Intervention on Fitnesgram test (for each dependent variable) scores from pre to post-test. Before applying ANOVA, MANOVA and follow-up ANOVA statistics were checked for four assumption tests. A significant level was determined as $p < .05$ for all analyses.

RESULTS

Results for Health-Related Fitness Knowledge Test

The mean and standard deviation of Health-related fitness knowledge levels of the experimental group and comparison group students are shown in Table 2. According to the findings intervention has significant effect on groups ($V=0.11$, $F(6,147)=13.95$, $p<.05$), time ($V=0.31$, $F(6,147) = 11.12$, $p<.05$) and group and time interaction ($V=0.36$, $F(6, 147)=13.95$, $p<.05$).

Table 2: Experimental and Comparison Group HRFK Test Descriptive Statistics

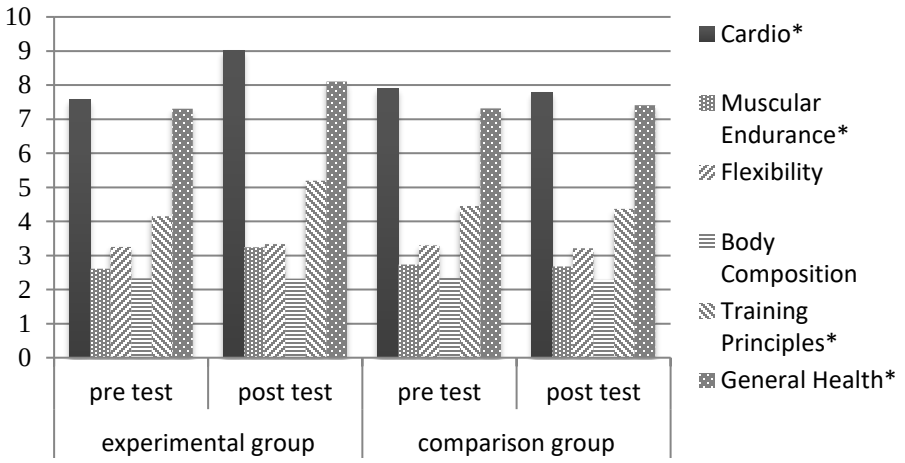
Health-Related Fitness Knowledge Test	Experimental Group				Comparison Group			
	Pre-test		Post-test		Pre-test		Post-test	
	M	SD	M	SD	M	SD	M	SD
Cardio*	7.57	0.84	9.03*	0.47	7.91	1.25	7.78	1.36
Muscular endurance*	2.61	0.66	3.24*	0.49	2.73	0.61	2.68	0.89
Flexibility	3.25	0.58	3.33	0.48	3.3	0.62	3.21	0.75
Body Composition	2.33	0.56	2.32	0.47	2.34	0.57	2.28	0.55

Training Principles*	4.15	0.74	5.19*	0.62	4.45	0.83	4.37	1.03
General Health*	7.31	0.88	8.1*	0.63	7.32	1.27	7.41	1.28

* Means at Pre-test and Post-test, $p < .05$.

Findings indicated that health-related fitness intervention significantly increased students' cardiovascular endurance $F(1,152)=48.61$, $p <.0001$, muscular endurance $F(1,152)=24.35$, $p<.0001$, training principles $F(1,152)=9.23$, $p<.05$ and general health knowledge level $F(1,152)=9.23$, $p <.05$. However the interaction of group and time has no significant effect on flexibility knowledge level $F(1,152)=.63$, $p <.05$) and body composition knowledge level $F(1,152)=.004$, $p <.05$). The mean scores of the HRF knowledge test sub-dimensions of the experimental and comparison groups during the pre and post-test were presented in figure 2.

Figure2: HRF Knowledge test mean scores of the groups during the pre-test and post-test.



Results for IPAQ-A

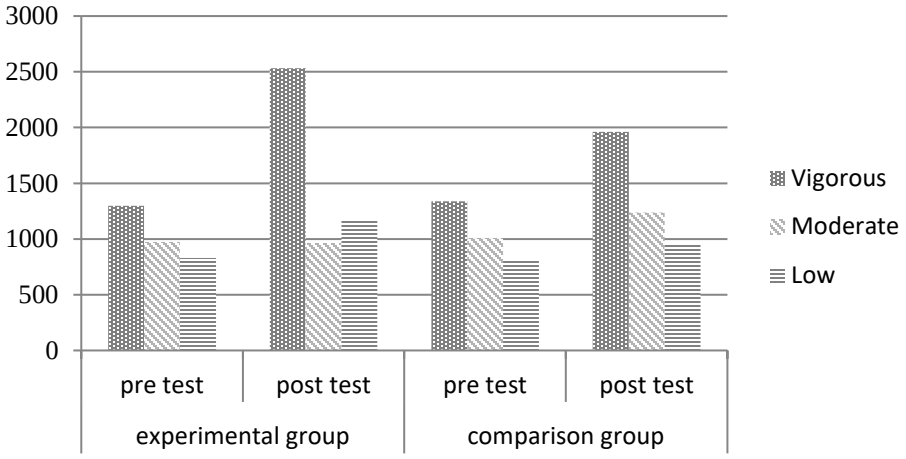
Physical activity level consists of three sub-dimensions: low, moderate and vigorous. The mean and standard deviations of each dimension from the pre-test to the Post-test for the experimental group and the comparison group are shown in Table 3.

Table 3: Experimental & Comparison Group Physical Activity Level Descriptive Statistics

PAL MET values	Experimental Group				Comparison Group			
	Pre-test		Post-test		Pre-test		Post-test	
	M	SD	M	SD	M	SD	M	SD
Vigorous	1297.22	2285.56	2532.5	2137.52	1337.56	1825.39	1960.35	2579.9
Moderate	972.78	653.07	966.11	593.38	1009.02	614.37	1237.8	849.1
Low	831.15	236.08	1169.22	138.45	810.16	163.33	955.95	123.93

The findings indicated that intervention has significant effect on the groups ($V=.25$, $F(3,152)=16.56$, $p<.0001$), time ($V=.67$, $F(3,152)=99.79$, $p <.002$), group and time interaction ($V=.28$, $F(3,152)=20.19$, $p <.0001$). In particular, the HRFPE course has a significant effect on student's low physical activity level $F(1,152)=36.11$, $p<.0001$, medium physical activity level $F(1,152)=4.67$, $p<.05$ and vigorous physical activity level $F(1,152)=4.94$, $p <.05$. The PAL mean scores of the experimental and comparison group during pre-test and post-test were presented in figure 3.

Figure 3: Physical Activity Level mean scores of the groups during the pre-test and post-test.



According to the findings of descriptive statistical analysis, although the low and vigorous physical activity levels of the experimental group students increased from pre-test to post-test, moderate physical activity levels decreased.

Results for Fitnesgram Tests

The components of the Fitnesgram tests are the pacer, push-up, curl-up, flexibility, and BMI. The mean and standard deviations of each dimension from the pre-test to the Post-test for the experimental group and the comparison group are shown in Table 4.

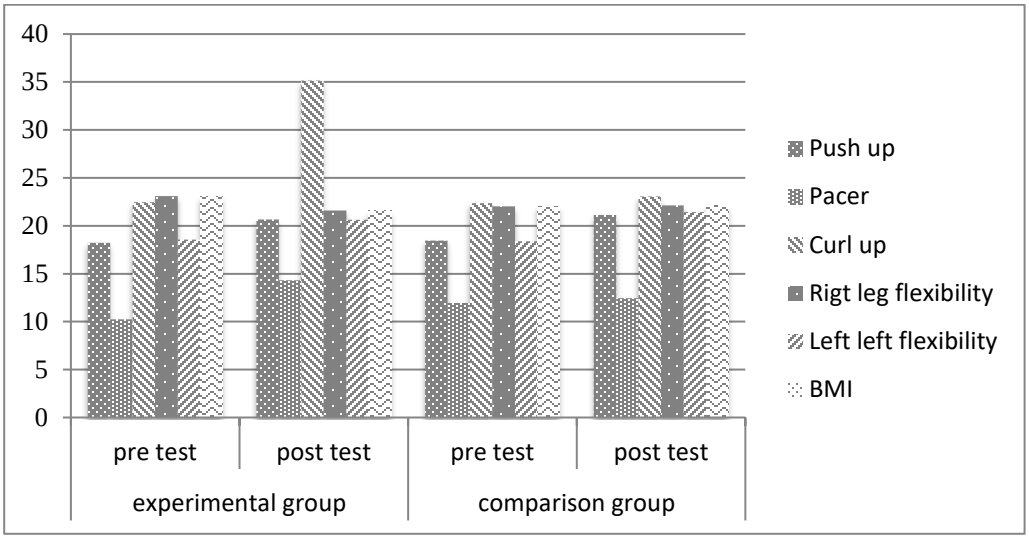
Table 4: Experimental and Comparison Group Fitnesgram Tests Descriptive Statistics

Fitnesgram Tests	Experimental Group				Comparison Group			
	Pre-test				Pre-test			
	M	SD	M	SD	M	SD	M	SD
Push up	18.22	6.97	20.65	5.77	18.44	6.4	21.11	6.07
Pacer	10.24	9.51	14.31	10.51	11.94	10.36	12.44	10.43
Curl up	22.47	12.36	35.13	10.12	22.37	10.47	23.07	9.94
Right leg flexibility	23.11	3.5	21.58	2.86	22.04	3.43	22.13	3.38
Left left flexibility	18.56	7.16	20.64	5.33	18.4	5.82	21.44	6.43
BMI	23.05	3.51	21.58	2.87	22.06	3.41	22.09	3.35

Descriptive statistics indicated that flexibility of the left leg and push-up test mean scores decreased from the pre-test to the post-test. However, right leg flexibility, pacer test, and curl-up test mean scores increased for the experimental group.

Subsequent univariate analysis revealed that right leg flexibility ($V=.45$, $F(1,152)=122.23$ $p<.0001$), pacer aerobic endurance performance ($V=.72$, $F(1,152)=58.04$, $p<.0001$) abdominal test endurance performance ($V=.68$, $F(1,152)=315.29$, $p<.0001$) and body mass index ($V=.45$, $F(1,152)=122.63$, $p<.01$) of the experimental group were better than the comparison group after intervention. However, the intervention did not significantly change left leg flexibility and push-up performance. The mean scores of the Fitnessgram physical fitness test sub-dimensions for the experimental and comparison groups during the pre and post-test were presented in figure 4.

Figure 4: Fitnessgram tests mean scores of the groups during the pre-test and post-test.



DISCUSSION

In this study, HRF Knowledge Test scores for cardiovascular system endurance, muscular system endurance, training principles, and general health knowledge subscales show the efficiency of SDT-based HRFPE course intervention. The outcomes are in parallel with previous studies indicating the cognitive influence of self-determination theory in HRFPE course intervention (Brusseau, Burns, & Hannon, 2016; Fortier, Duda, Guerin, & Teixeira, 2012; Silva, Marques, & Teixeira, 2014). However, there was no significant difference in flexibility and body composition knowledge subscales. The structure of the questionnaire can explain this situation for flexibility. There are only 4 questions in the IPAQ-A, and students in the experimental group increased their mean scores from 3.25 to 3.33 over 4. HRFPE course increased students' flexibility knowledge, but it is statistically insignificant because of the narrow range. The body composition subject is included in the primary school's 7th-grade and 9th-grade curriculum in Health Knowledge Course (Çelenkoğlu, 2019). Therefore, it can be explained that the students' average values are high, and there is no difference between the groups and their pre-test and post-test scores.

According to IPAQ-A, HRFPE course intervention increased students' low and vigorous physical activity MET values in the experimental group. The findings support previous studies demonstrating the influence of the self-determination theory in changing physical activity habits. A study conducted with 10th-grade high school students applied an HRFPE course. It was found that moderate and high levels of physical activity MET values of the students increased, and the body fat rates, and waist circumference decreased (Gorely, Nevill, Morris, Stensel, & Nevill, 2009). Another study with a large population (N=1421) showed that SDT-based physical education intervention increased students' moderate to vigorous physical activity levels in physical education courses and leisure time (Lonsdale et al., 2013).

The results of the Fitnessgram performance tests showed augmentation in pacer run, body mass index, curl up and right leg flexibility, and performances of the experimental group. Prior studies in the literature, (Derri, Aggeloussis, & Petraki, 2004; Ignico & Mahon, 1995; Rengasamy, 2012; Sallis et al., 1997; Singh, 2005), showed that SDT-based HRFPE course intervention increased individuals' aerobic capacity and other physical performances as well. However, there was no significant difference in left leg flexibility and push-up performances between the experimental and comparison groups during the pre-test and post-test periods.

Unexpectedly, the study did not significantly change the performance of the push-ups. This state can be explained by the fact that 65% of the students were female, and push-up movement, which mainly focuses on arm and shoulder muscle power and endurance, is considered masculine and not attractive for females. They mostly prefer aerobics, walking, gymnastics, pilates and yoga (Raustorp, Ståhle, Gudasic, Kinnunen, & Mattsson, 2005).

Another unexpected result of the study was that there was no significant change in left leg flexibility. This result is mainly due to three reasons first, lack of emphasis on stretching exercises in physical education classes (D.

L. Katz et al., 2010), followed by the weakness and less flexibility of the dominant foot compared to the other foot(Hart & Gabbard, 1996) (Hart & Gabbard, 1996), and finally as a result of the severe pain caused by the sudden elongation of muscle length in flexibility studies. It can be explained by the fact that students did not care about flexibility studies and were reluctant to participate in these exercises.

In this study, HRFPE intervention based on self-determination theory delivers high motivation, interest and value, effectively improving health-related knowledge levels, physical activity habits and physical fitness performances. Despite the similarities of HRFPE intervention with the literature, this study raised essential discussion topics in theory and practice in physical education. This study showed that students in the experimental group increased their overall HRF knowledge level in parallel with their overall physical activity level and some fitness levels.

In this context, this study is unique in several aspects; Firstly, participants who were 9th-grade adolescents, ages to gain positive behavioural life habits. Secondly, the study differs from others by revealing the positive effect of SDT-based HRFPE course interventions on students' HRF Knowledge, physical activity levels and health-related fitness performances.

CONCLUSIONS

This study's first line showed the HRF intervention's effect on 9th-grade students' HRF knowledge levels. Our findings showed that overall, HRF Knowledge levels of children were positively and significantly affected by eight-week HRFPE interventions. Specifically, students' knowledge of cardiovascular endurance, muscular strength & endurance, body composition, and training principles sub-concepts increased significantly.

The second lane of this study showed the effect of a health-related fitness intervention on 9th-grade students' physical activity levels. The findings indicated that HRFPE intervention significantly increased students' overall physical activity levels. In particular, HRFEC intervention significantly increased students' low and vigorous physical activity sub-levels. The intervention has been most effective for the low physical activity sub-level. In conclusion, HRFPC intervention can change young people's PA behaviour by initiating sports with low physical activity (for example, walking and jogging), at least in the short term. This study is one the advocates that HRFPE intervention is more effective than a skill-based physical education program.

The current study's third lane revealed the HRFPE intervention's effect on 9th-grade students' physical fitness levels. The findings of the study demonstrated that HRPEC significantly increased students' aerobic capacity (pacer test), abdominal muscle strength and endurance (sit-up test), right leg flexibility (sit and reach test) and body mass index (kg/m2) levels. On the other hand, an eight-week health-related fitness intervention was insufficient to change 9th-grade students' left leg flexibility and upper body strength (push-up test) levels. The recommendations for flexibility knowledge could apply to the practical aspects of the study in that allocating more time for stretching with elastic goods could increase students' flexibility levels or at least make flexibility exercises more attractive for the students.

It was observed that girls mostly worry about muscular workouts because of their large muscles and masculine appearance. Physical educators should bring a solution to girls' muscular appearance problems without ignoring the importance of upper body strength for the maintenance of daily physical activities. Another recommendation for physical educators is the content of the physical education program. The PE program needs to be reconstructed to give more detailed information about muscular workouts in terms of type, intensity and volume, which may cause appearance dissatisfaction. In addition, girls engage more with stretching, walking, aerobics and pilates exercises, whereas boys engage more with strength and aerobic exercises. It could also be recommended for physical educators to bring strength exercises in an attractive and facilitator form with new sports equipment.

Skill-based physical education course content, which is taught as a must course in schools, did not consist of enough health information and behavioural component to developing the meaning and value of physical activity for high school students. Self Determination Theory-based HRFPE intervention used in this study for the 9th-grade high school students brings new perspectives to the literature. The current study could be a reference for the researchers to estimate the optimal conditions for an effective SDT-based HRFPE intervention in terms of the qualifications of the physical education and HRF physical education course content instructions and teaching styles.

It could be recommended for physical educators to include peers, family, social environment, and homework in HRFPE interventions. Also, long-term follow-ups could be recommended for further researchers to discover the effects of HRFPE in the long term.

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