

A Follow-Up Cohort Study on Physical Activity Levels in Turkish Adolescents

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Abstract

Aim: Regular physical activity (PA) is essential for maintaining health and preventing chronic diseases. However, global evidence shows a consistent decline in PA during adolescence, with Turkish adolescents similarly experiencing increasing levels of inactivity over the last decades. Adolescence represents a critical developmental stage where PA habits are established and influence long-term health outcomes, yet longitudinal evidence from Türkiye remains limited. This study aimed to examine 18-month changes in PA among Turkish adolescents using a prospective cohort design.

Method: This study was planned as a prospective cohort study. 296 adolescents (grades 5–8, aged 11–13 years) who completed the baseline survey between November – December 2022, a randomly selected subsample of 192 students from one school was followed up in May-June 2024. PA levels were assessed at both time points using anthropometric measures and the validated Turkish version of the Physical Activity Questionnaire for Older Children (PAQ-C).

Results: A total of 157 participants (boys, n=74; girls, n=83) completed assessments at both time points. Significant decreases were observed in six of nine PAQ-C items for boys and two of nine items for girls ($p < 0.05$). School-time PA (items 2–4) showed significant reductions, while spare-time and extracurricular PA (items 1 and 5–9) remained largely unchanged ($p > 0.05$). Gender differences indicated greater reductions among boys compared with girls.

Conclusions: Over an 18-month period, PA levels among Turkish adolescents declined, with reductions most evident in school-time PA and more pronounced among boys. These findings underscore the need for longitudinal monitoring of adolescent PA in Türkiye. There is limited study estimating the follow-up on physical activity in the Turkish adolescent population.

Keywords: Adolescent, physical activity, prospective, cohort.

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ETHICAL STATEMENT: This study has the necessary approvals from local governments and the ethical approval from the Ethics Committee of Marmara University Institute of Health Sciences (No: 38 Date: 21.03.2022).

Adölesanlarda Fiziksel Aktivite Düzeyleri Üzerine Bir İzlem Kohort Çalışması

Öz

Amaç: Düzenli fiziksel aktivite (FA), sağlığın korunması ve kronik hastalıkların önlenmesi açısından hayati öneme sahiptir. Ancak, küresel bulgular adölesan dönemde FA'da tutarlı bir azalma olduğunu göstermekte, Türk adölesanların da son on yıllarda giderek artan hareketsizlik düzeyleri yaşadığı bildirilmektedir. Adölesan dönem, FA alışkanlıklarının oluştuğu ve uzun dönem sağlık sonuçlarını etkilediği kritik bir gelişim evresini temsil etmektedir; ancak Türkiye'de bu konuda uzunlamasına kanıtlar sınırlıdır. Bu çalışma, prospektif kohort tasarımı kullanılarak adölesanlar arasında 18 aylık süreçte FA'daki değişimleri incelemeyi amaçlamıştır.

Yöntem: Bu çalışma, prospektif kohort çalışması olarak planlanmıştır. Kasım–Aralık 2022 döneminde temel anketi tamamlayan 296 adölesan (5.–8. sınıf, 11–13 yaş), bunlardan rastgele seçilen bir okuldan 192 öğrenci Mayıs–Haziran 2024'te tekrar takip edilmiştir. Her iki zamanda da antropometrik ölçümler ve Fiziksel Aktivite Anketi–Çocuklar için Versiyonunun (PAQ-C) Türkçe geçerlilik çalışması yapılmış formu kullanılarak FA düzeyleri değerlendirilmiştir.

Bulgular: Toplam 157 katılımcı (erkek, n=74; kız, n=83) her iki zamanda da değerlendirmeyi tamamlamıştır. Erkeklerde dokuz PAQ-C maddesinin altısında, kızlarda ise iki maddede anlamlı düşüş gözlenmiştir ($p<0,05$). Okul zamanı FA (maddeler 2–4) belirgin olarak azalmış, boş zaman ve ders dışı FA (maddeler 1 ve 5–9) ise büyük ölçüde değişmemiştir ($p>0,05$). Cinsiyet farklılıkları, erkeklerde kızlara kıyasla daha büyük azalmalar olduğunu göstermiştir.

Sonuç: On sekiz aylık dönemde adölesanlarda FA düzeylerinde düşüş gözlenmiş, en belirgin azalmalar okul zamanı FA'da ve erkeklerde görülmüştür. Bu bulgular, Türkiye'de ergen FA'sının uzunlamasına izlenmesinin gerekliliğini ortaya koymaktadır. Türkiye'de ergenlerde FA'nın takip edilmesine yönelik çalışmalar halen sınırlıdır.

Anahtar Sözcükler: Adölesan, fiziksel aktivite, prospektif, kohort.

Introduction

According to the World Health Organization (WHO), physical inactivity and high sedentary time are the fourth and fifth leading causes of death worldwide, trailing behind high blood pressure, tobacco use, and overweight and obesity. Physical inactivity and the resulting plethora of consequences have globally emerged as major public health issues¹.

Regular physical activity has been shown to have several benefits, mainly improving overall health and delaying or preventing the development of multiple morbid states such as type 2 diabetes, hypertension, obesity, and many others². Therefore, for children and adolescents between 5 to 13 years, it is recommended to participate in at least 60 minutes of moderate to vigorous PA daily to promote health. Unfortunately, Turkish adolescents are not immune to physical inactivity, and data support secular increment trends in physical inactivity rates in the last decades³. A 2013 national report by the Turkish Ministry of Health presented the PA profiles among adolescents and highlighted a worrisome trend of physical inactivity and sedentary behavior patterns⁴⁻⁶.

Adolescence represents a critical developmental stage during which health-related behaviors, including PA, are established and carried into adulthood. A consistent decline in PA levels during adolescence has been documented across multiple international

cohort studies, with gender, social environment, ecological factors, and behavioral determinants influencing these trajectories^{7,8}. For example, girls are generally less active than boys, and both sexes experience significant reductions in PA as they transition through adolescence⁹. Longitudinal studies further demonstrate that reduced PA during this period is associated with adverse health outcomes in later life¹⁰. Despite the importance of these findings, most existing studies in Türkiye are cross-sectional, limiting the ability to understand temporal changes in PA behaviors. There is a limited study estimating the follow-up on physical activity in the Turkish adolescent population^{11,12}.

To address this gap, the present study aims to investigate changes in physical activity among Turkish adolescents using a prospective cohort design with an 18-month follow-up. By examining PA behavior over time in school-going adolescents, this study provides novel insights into the dynamics of PA in this population. The findings are expected to inform the Turkish Ministry of Health in developing evidence-based public health strategies and interventions to mitigate physical inactivity and its long-term consequences.

Material and Methods

Study Design and Participants

This study was designed as a prospective cohort study based on a previous data collection conducted among adolescent school children in Üsküdar, Istanbul, Türkiye. At baseline, a total of 296 students aged 11–13 years (grades 5–8) were recruited from three of the 39 public secondary schools in the district. The primary aim of the original baseline study was to assess personal, ecological, and social factors associated with physical activity levels among Turkish adolescents.

For the current research, an 18-month follow-up survey was conducted to examine longitudinal changes in physical activity within the same cohort. Due to limited resources, only one of the original three schools was randomly selected to participate in the follow-up data collection.

Data Collection

Baseline data (Time 1) were collected between November and December 2022, while the follow-up (Time 2) took place between May-June 2024, approximately 18 months later. At both time points, data collection included anthropometric measurements and the administration of the validated Turkish version of the Physical Activity Questionnaire for Older Children. Students who self-reported acute or chronic health conditions that would restrict participation in PA were excluded from the study.

The method of administration differed between the two time points. At Time 1, questionnaires were completed in person during school visits by trained research assistants. At Time 2, data collection was conducted through an online platform. For the online administration, parents or legal guardians were asked to provide assistance, if necessary, to ensure accurate completion of the questionnaires.

Physical Activity Questionnaire for Older Children: The Turkish version of PAQ-C was used to obtain information on PA levels among participants^{13,14}. The original version of PAQ-C was developed by Crocker et al., and consisted of 10 items¹³. Erdim et al. translated the self-report PAQ-C questionnaire into the Turkish language and modified Item 1. The original Item 1 listed 22 seduced 14 sports as some to marks not relevant to Turkish culture¹⁵. The authors demonstrated two-factor structures in PAQ-C: items 2 to 4 loaded on Factor 1, termed as school time PA, and items 1, 5 to 9 loaded on Factor 2, termed as extracurricular PA. For this study, we will present data separately for school-time PA (Factor 1) and extracurricular PA (Factor 2). Item 10 queried participants if they experienced any illness or barrier that prevented them from participating in regular PA. Participants with the positive response to item 10 were excluded from the analysis.

Item 1 of the Turkish version of PAQ-C queried participants to rate their frequency of participation in any or all of the 14 sports in the last 7 days. Each sports activity has five options: 1 - did not participate, 2 to 5 describing participation frequency from 1 to 2, 3 to 4, 5 to 6, and more than 7 times.

The original scoring algorithm for PAQ-C suggested assigning an ordinal score to each frequency option (1 to 2 times per week=1, 3 to 4 times per week=2, and so on) and calculating an average score for item 1. This scoring method suggests a mathematical meaning to this incorrect assignment. Therefore, a midpoint value was assigned to account for the false ordinality. For instance, if a participant has selected participating is skipping an activity 1 to 2 times in the last 7 days, a mid-value of 1.5 is assigned for that sports activity. A final score for item 1 was calculated by summing all mid-scores and dividing by the total number of sports. For Items 2 to 9, rated on a 5-point descriptive scale, a score of 1 (low) to 5 (high) was assigned.

For this study, we calculated two scores using the factor analysis structure reported by Erdim et al.; school time PA (Factor 1), the average of scores from items 2 to 4 and extracurricular PA (Factor 2) is the average of scores for items 1, and 5 to 9. Data is also presented separately for boys and girls by each entity¹⁵.

Ethical Statement

This study has the necessary approvals from local governments and the ethical approval from the Ethics Committee of Marmara University Institute of Health Sciences (No: 38 Date: 21.03.2022). Written informed consent was obtained from the parents.

Statistical Analysis

Descriptive statistics (mean and standard deviation or proportions) are presented to characterize the cohort. A paired t-test was used to compare the scores at baseline and follow-up periods. Standardized response mean (SRM) was presented for the effect size, and a 95% confidence interval (CI) for the mean difference was calculated for the combined sample and separately for boys and girls. The SRM was calculated as a ratio of the mean change score by the standard deviation of the change score¹⁶. A SRM score <0.2

was considered as trivial, ≥ 0.2 to < 0.5 as small, ≥ 0.5 to < 0.8 as moderate, and ≥ 0.8 as large effect sizes^{14,16-18}. All analyses were performed using SPSS 20.0.

Results

Of 192 participants, 35 participants (12 boys and 23 girls) responded that they had an acute or chronic health condition that interfered with their PA in the last 7 days (item 10). Therefore, those data were excluded from the analysis. A total of 74 boys and 83 girls completed the questionnaires at two time points, and their characteristics are presented in Table 1. The mean (standard deviation: SD) age was 13.1 (0.7) years for boys and 12.9 (0.7) years for girls.

Table 1. Descriptive characteristics of the participants

	Boys (n=74) Mean (SD)	Girls (n=83) Mean (SD)
Age in years	13.0 (0.7)	12.9 (0.7)
BMI in kg/m ² Baseline	20.0 (3.0)	18.8 (2.8)
Follow-up	22.0 (3.7)	19.7 (3.2)

Abbreviations: BMI: Body mass index, SD: Standard deviation.

Table 2 presents the paired t-tests for the total sample and separately by sex, with 95% CI and SRM. Significant differences were found in almost all items of the PAQ-C scores between baseline and follow-up periods ($p < 0.05$) for both boys and girls, except for the item 5 (after school PA) and 7 (weekend) for boys and Items 1 (spare time PA), 4 (recesses), 8 (statement), and 9 (weekly activity) for girls ($p > 0.05$). There were significant differences between baseline and follow-up periods on the mean scores: spare time PA (95% CI= -0.7 to -0.2 and -1.1 to -0.2 for total scores and boys), before school PA (95% CI= -1.3 to -0.7, -1.4 to -0.7, and -1.5 to -0.5 for whole sample, boys and girls), physical education (95% CI= -1.3 to -0.7, -1.6 to -0.7, and -1.4 to -0.4 for whole sample, boys and girls), recesses (95% CI= -0.9 to -0.3 and -1.3 to -0.4 for whole sample and boys), after school PA (95% CI= 0.2 to 0.8 and 0.4 to 1.2 for whole sample and girls), evenings (95% CI= 0.4 to 0.9, 0.0 to 0.8, and 0.5 to 1.2 for whole sample, boys and girls), weekend (95% CI= 0.1 to 0.5 and 0.2 to 0.8 for whole sample and girls), statement (95% CI= -0.6 to -0.1 and -0.8 to -0.2 for whole sample and boys), and weekly activity (95% CI= -0.7 to -0.3 and -1.1 to -0.5 for whole sample and boys) The SRM ranged between 0.03 to 0.33, 0.01 to 0.64, and 0.04 to 0.47 for individual items for whole sample, boys, and girls respectively (Table 2).

Table 2. Item level change in PAQ-C scores from baseline to follow-up

	Total (n=157) Mean (SD)	Boys (n=74) Mean (SD)	Girls (n=83) Mean (SD)
Spare time for physical activity (Item 1)			
Baseline	3.1 (1.1)	3.3 (1.1)	3.0 (1.1)
Follow-up	2.7 (1.4)	2.6 (1.4)	2.7 (1.3)
Mean difference (95%CI)	-0.5 (-0.7 to -0.2)	-0.7 (-1.1 to -0.2)	-0.3 (-0.7 to 0.1)
p	0.002	0.003	0.159
SRM	0.03	0.07	0.04
Before school physical activity (Item 2)			
Baseline	4.0 (1.3)	4.0 (1.1)	4.0 (1.5)
Follow-up	3.0 (1.3)	3.0 (1.2)	3.0 (1.4)
Mean difference (95%CI)	-1.0 (-1.3 to -0.7)	-1.1 (-1.4 to -0.7)	-1.0 (-1.5 to -0.5)
p	<0.001	<0.001	<0.001
SRM	0.29	0.60	0.47
Physical education (Item 3)			
Baseline	3.0 (1.7)	3.3 (1.6)	2.7 (1.8)
Follow-up	2.0 (1.3)	2.2 (1.5)	1.8 (1.1)
Mean difference (95%CI)	-1.0 (-1.3 to -0.7)	-1.1 (-1.6 to -0.7)	-0.9 (-1.4 to -0.4)
p	<0.001	<0.001	<0.001
SRM	0.28	0.46	0.28
Recess (Item 4)			
Baseline	2.7 (1.4)	3.0 (1.5)	2.5 (1.3)
Follow-up	2.2 (1.4)	2.1 (1.4)	2.2 (1.4)
Mean difference (95%CI)	-0.6 (-0.9 to -0.3)	-0.8 (-1.3 to -0.4)	-0.3 (-0.8 to 0.1)
p	<0.001	<0.001	0.122
SRM	0.08	0.26	0.10
After school physical activity (Item 5)			
Baseline	2.2 (1.3)	2.2 (1.3)	2.2 (1.3)
Follow-up	2.7 (1.5)	2.4 (1.4)	3.0 (1.4)
Mean difference (95%CI)	0.5 (0.2 to 0.8)	0.2 (-0.2 to 0.6)	0.8 (0.4 to 1.2)
p	<0.001	0.370	<0.001
SRM	0.24	0.07	0.32
Evenings (Item 6)			
Baseline	2.0 (1.2)	1.8 (1.2)	2.1 (1.2)
Follow-up	2.6 (1.4)	2.2 (1.4)	2.9 (1.3)
Mean difference (95%CI)	0.6 (0.4 to 0.9)	0.4 (0.0 to 0.8)	0.8 (0.5 to 1.2)
p	<0.001	0.037	<0.001
SRM	0.24	0.07	0.31
Weekend (Item 7)			
Baseline	2.4 (1.1)	2.4 (1.1)	2.4 (1.0)
Follow-up	2.7 (1.3)	2.4 (1.3)	2.9 (1.3)
Mean difference (95%CI)	0.3 (0.1 to 0.5)	0.1 (-0.3 to 0.5)	0.5 (0.2 to 0.8)
p	0.014	0.614	0.003
SRM	0.18	0.01	0.26
Statement (Item 8)			
Baseline	2.7 (1.1)	2.7 (1.2)	2.6 (1.1)
Follow-up	2.3 (1.2)	2.3 (1.2)	2.3 (1.2)
Mean difference (95%CI)	-0.4 (-0.6 to -0.1)	-0.5 (-0.8 to -0.2)	-0.3 (-0.6 to 0.1)
p	0.002	0.004	0.111
SRM	0.16	0.24	0.11
Weekly activity (Item 9)			
Baseline	3.0 (1.0)	3.1 (1.0)	2.9 (0.9)
Follow-up	2.5 (1.0)	2.3 (1.0)	2.7 (0.9)
Mean difference (95%CI)	-0.5 (-0.7 to -0.3)	-0.8 (-1.1 to -0.5)	-0.2 (-0.4 to 0.1)
p	<0.001	<0.001	0.177
SRM	0.33	0.64	0.12

Abbreviations: PAQ-C: Physical Activity Questionnaire for Older Children, CI: Confidence Intervals, SD: Standard Deviation, SRM: Standardized Response Mean.

Table 3 presents the change in PAQ-C total scores from baseline to follow-up with 95% CI and SRM scores. There was a significant decrease in school time PA (Items 2, 3, and 4) for the whole sample (95% CI= -0.6 to -1.1), boys (95%CI= -1.3 to -0.7), and girls (95%CI= -0.4 to -1.1). The SRM for the whole sample, boys, and girls was 0.04, 0.59,

and 0.47. There was no significant difference observed between spare time and extracurricular PA (Items 1 and 5 to 9).

Table 3. Change in PAQ-C total scores from baseline to follow-up

	Total (n=157) Mean (SD)	Boys (n=74) Mean (SD)	Girls (n=83) Mean (SD)
School time physical activity (Items 2, 3, and 4)			
Baseline	3.2 (1.1)	3.4 (1.1)	3.1 (1.1)
Follow-up	2.4 (1.1)	2.4 (1.1)	2.3 (0.9)
Mean difference (95%CI)	-0.9 (-0.6 to -1.1)	-1.0 (-1.3 to -0.7)	-0.7 (-0.4 to -1.1)
p	<0.001	<0.001	<0.001
SRM	0.04	0.59	0.47
Spare time and extracurricular physical activities (Items 1 and 5 to 9)			
Baseline	2.6 (0.8)	2.6 (0.7)	2.6 (0.8)
Follow-up	2.6 (1.0)	2.4 (1.1)	2.8 (0.9)
Mean difference (95%CI)	0.0 (-0.2 to 0.2)	-0.2 (-0.5 to 0.0)	0.2 (0.0 to 0.5)
p	0.820	0.074	0.068
SRM	0.01	0.14	0.10

Abbreviations: PAQ-C: Physical Activity Questionnaire for Older Children, CI: Confidence intervals, SD: Standard deviation, SRM: Standardized response mean.

Table 4 shows the sample proportion that changed PAQ-C scores by at least 1/2 a standard deviation at the baseline level. Around 66% boys (n=49) and 55% girls (n=46) dropped on PAQ-C scores for school time PA. For spare time and extracurricular PA, 45% of boys (n=33) and 39% of girls (n=32) showed a reduction in PAQ-C scores.

Table 4. The proportion of the sample that dropped on PAQ-C scores by at least 1/2 a standard deviation at follow-up

Categories of physical activity	Total n of 157 [%]	Boys n of 74 [%]	Girls n of 83 [%]
Factor 1: School time physical activity (Items 2, 3, and 4)	95 [61]	49 [66]	46 [55]
Factor 2: Spare time and extracurricular physical activities (Items 1 and 5 to 9)	65 [41]	33 [45]	32 [39]

Abbreviations: PAQ-C: Physical Activity Questionnaire for Older Children.

Discussion

This prospective cohort study provides novel insights into changes in physical activity among Turkish adolescents across an 18-month follow-up period. Our results showed a decline in school-time PA between the two time points, while spare-time and extracurricular PA remained largely unchanged. This pattern suggests that reductions in structured school-related opportunities for PA may not have been compensated by unstructured activity in other domains¹⁹.

Gender differences were evident in the findings, with boys experiencing greater reductions in PA than girls. One possible explanation is that boys are more likely to engage in structured or team-based sports, whereas girls may incorporate PA into daily life activities that can be maintained independently²⁰. This interpretation is supported by international cohort studies showing that boys' PA is particularly sensitive to changes in school and peer-related contexts, while girls are more likely to sustain PA through informal and household activities^{8,21}. At baseline, boys reported higher school-time PA levels compared with girls, which may also explain why the relative reduction was greater for boys during follow-up.

Differences in extracurricular PA responses further highlight behavioral and social adaptation strategies. Boys reported reductions in several extracurricular PA items, with slight increases in only one area, while girls reported increases in three of the five extracurricular PA items. These findings may indicate that girls were better able to compensate for decreases in school-time PA by adapting their leisure activities²². Another explanation may be that girls, who initially reported lower PA levels than boys, had less scope for further reductions, which aligns with previous literature documenting sex differences in adolescent PA²³.

The effect size analysis provides additional insight. For girls, most PAQ-C parameters showed small effects, with medium effects observed only for reductions in before-school PA and school-time PA. For boys, however, medium effects were detected for decreases in before-school PA, physical education, weekly activity, and total school-time PA, suggesting that the most pronounced changes occurred in structured or scheduled activity contexts. These findings are consistent with other international longitudinal studies, which report that declines in adolescent PA are most apparent in organized or curriculum-based activity domains¹⁰.

The strengths of this study include the large baseline sample, prospective design, and use of the validated PAQ-C questionnaire at two distinct time points. Unlike much of the existing literature, which has relied on retrospective recall, this design allowed for more accurate capture of changes in PA behavior over time²⁴. Nonetheless, some limitations should be acknowledged. First, the follow-up sample was smaller due to resource constraints, which may limit the generalizability of the findings. Second, seasonal variation may have influenced results, as baseline data were collected in winter (November–December 2022), while follow-up data were collected in spring (May–June 2024). Finally, follow-up data were obtained from one school only, which restricts representativeness across the wider adolescent population in Türkiye.

Conclusion

In conclusion, this study demonstrates a measurable decline in school-time PA among Turkish adolescents over an 18-month period, with notable gender differences in adaptation and compensation strategies. There is a limited study estimating the follow-up on physical activity in the Turkish adolescent population. Our findings underscore the need for longitudinal monitoring of PA in adolescents and may guide the Ministry of Health in developing evidence-based policies and interventions to address inactivity during this critical developmental stage.

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