Journal of Public Health: From Theory to Practice (2019) 27:49–56
https://doi.org/10.1007/s10389-018-0923-7

ORIGINAL ARTICLE

Relationship between musculoskeletal disorders and physical inactivity in adolescents

Semra Aktürk[1] · Raikan Büyükavcı[1] · Ümmühan Aktürk[2]

Received: 29 January 2018 / Accepted: 20 April 2018 / Published online: 18 May 2018

Abstract

Purpose To determine the correlation between musculoskeletal system disorders and the physical activity levels of adolescents.

Methods A total of 417 high school students were included in this cross-sectional study. To explain the musculoskeletal pain and physical activity, a self-administered questionnaire which included the Nordic International Physical Activity Questionnaire Short Form (IPAQ-SF) was distributed.

Results The standardised Nordic musculoskeletal questionnaire showed that 57.3% of the students reported having musculoskeletal disorders in one or more body parts, and 52.2% of them consisted of girls. The mean weekly energy consumption as linked to the physical activity of the participants was found to be 2534.58 (± 2371.31) metabolic equivalent task (MET/wk): 45.8% of the individuals exhibited low levels of activity. A statistically significant relationship was found between experiencing upper/low back pain and the participants' low physical activity levels.

Conclusions The current study has shown that the prevalence of MSDs was high among high school students, with a correlation being found between low physical activity and back pain. Physical activity levels should hence be considered when evaluating adolescents with musculoskeletal disorders.

Keywords Back pain · Musculoskeletal disorders · Physical inactivity · Adolescents

Introduction

Musculoskeletal pain has been reported as a problem among adolescents (Sundblad et al. 2008). Recent reports have found a strong correlation between the amount of physical activity and health in grown-up individuals. Musculoskeletal system diseases (MSDs) represent one of the most significant health problems seen also in working populations worldwide (Ozcan et al. 2007). As the leading cause of pain and loss of function, such MSDs cause different levels of disruption to individuals' quality of life (Yılmaz et al. 2006).

It is assumed that the causes of musculoskeletal complaints are multifactorial (Huang et al. 2002; Andersen et al. 2003). Occupational factors such as prolonged static muscle load and repetitive work (Bernard 1997; Ariens et al. 2000; Palmer and Smedley 2007) may be a source for pain development. Gender and physical activity are also factors that may be associated with musculoskeletal pain.

Physical activity is defined as all bodily motions that result from energy expenditure (Pate et al. 1995). Physical inactivity is closely related to an increased risk of cardiovascular disease, diabetes mellitus, osteoporosis, and certain types of cancer (Hardman 2001; Anderson 2000; Duppe et al. 1997). Furthermore, it is reported that physical inactivity during growth might lead to impaired health later in life (Barnekow et al. 1998). In Turkey, adolescents today are considerably less physically active compared with adolescents a decade ago. The majority of adolescents prefer to watch television and/or use the computer instead of participating in sports or physical activities. It may therefore be important to identify possible risk factors among adolescents in order to prevent the development of musculoskeletal pain later in life. Inconsistent results can be seen in the literature with regard to the correlation between physical activity and MSDs, which means that there is no consensus on this subject (Barnekow et al. 2007; Holth et al. 2008; Briggs et al. 2009).

✉ Semra Aktürk
semrakayakturk@hotmail.com

[1] Department of Physical Medicine and Rehabilitation, Faculty of Medicine, Inönü University, Malatya, Turkey

[2] Department of Public Health Nursing, Faculty of Health Sciences, Inönü University, Malatya, Turkey

The aim of the present study is therefore to determine the correlation between musculoskeletal system disorders and the physical activity levels in high school students. Based on these aspects, another aim was to compare gender, body mass index, and academic year of the students, which may have an effect on musculoskeletal pain.

Materials and methods

This cross-sectional study was conducted in a high school in Malatya, Turkey…during November 2017. The study participants comprised 467 high school students. The exclusion criteria for the study were a history of any injury or trauma to any body part, spinal deformities, metabolic or connective tissue diseases, any surgical intervention, and severe physical disability causing pain. The study was approved by the Scientific Research and Ethical Committee of İnönü University.

A self-administered questionnaire was distributed to the participating students during school hours. The instructions for the questionnaire were explained by one of the authors as well as the data collector, who was well informed regarding all the parts of the questionnaire. The questionnaire was divided into three sections.

First, the questionnaire asked about the participants' demographic characteristics, for example, their age, gender, weight, height, and year of study.

Second, the questionnaire featured the standardised Nordic musculoskeletal questionnaire. This questionnaire includes an image of the human body, viewed from the back, which is divided into the nine anatomical regions that are usually affected by MSDs (Kuorinka et al. 1987). This questionnaire, which has previously been validated in Turkish (Kahraman et al. 2016), is a binary response questionnaire, with 'yes' and 'no' indicating the presence or absence respectively of MSDs. The participants were asked to indicate whether they had experienced an episode of pain/discomfort in any of the body parts mentioned in the questionnaire (i.e., the neck, shoulders, elbows, wrists and hands, upper back, lower back, hips, knees, ankles, and feet) during the past 12 months (period prevalence) and the past 7 days (point prevalence). Information regarding the severity of the musculoskeletal symptoms (MSSs) experienced during the past 12 months (if those MSSs affected their normal daily activities) was also obtained.

The third part of the utilised questionnaire comprised the International Physical Activity Questionnaire Short Form (IPAQ-SF), which was used to determine the participants' level of physical activity (Craig et al. 2003). It consists of four questions that ask participants to recall aspects of their physical activity over the previous 7 days. The Turkish validity and reliability of the IPAQ-SF have previously been confirmed (Saglam et al. 2010). The data obtained from the IPAQ-SF were summarised according to the physical activities recorded (walking, moderate and vigorous/intense activities) and the estimated time spent sitting down per week. Both the short- and long-form data were then used to estimate the participants' total weekly physical activity by weighting the reported minutes per week spent on each activity category by the metabolic equivalent task (MET) energy expenditure estimate assigned to each category of activity.

Statistical analysis

All statistical analyses were performed using SPSS version 17.0 for Windows. Descriptive statistics were presented based on means and standard deviation (SD). To compare the physical activity levels of those with musculoskeletal system symptoms and those without such symptoms, chi-square test was used for the categorical variables, while the independent samples *t*-test was used for the quantitative variables. A binary logistic regression analysis (stepwise selection) was performed in order to investigate the other factors that might affect MSSs. Statistical significance was defined as a P value ≤ 0.05 (Lang and Altman 2013).

Results

Out of 467 students recruited, 50 did not meet the inclusion criteria. A total of 417 students, 50.4% females and 49.6% males, were enrolled in the study. Mean age was 16.09 (± 0.9) years. The demographic data of the students are presented in Table 1.

The rate of those who complained of pain in the last year in any part of the body was 57.3%, and 52.2% of them consisted of girls. We found that the rate for those who reported experiencing upper back pain during any period of their lives was 29.7%, with the rates for neck pain and low back pain being 28.8% and 26.9% respectively. Investigating the 12-month prevalence of MSSs indicated the upper back to be the most common site of such symptoms, followed by the neck and the lower back (Table 2). A similar number of females and males reported back pain (Table 3). The data concerning the frequency with which the participants experienced these pains (often, rare, continuous) are presented in Table 2.

The mean weekly energy consumption as linked to the physical activity of the participants was found to be 2534.58 (±2371.31) MET-min/wk. When the individual cases were classified according to their physical activity level, 32.4% of participants exhibited a sufficient level of activity, while 45.8% exhibited low levels of activity, and 21.8% were found to engage in the least amount of physical activity possible (i.e., inactive). The time spent by students sitting around in a day was calculated as approximately 7 h (Table 1). When

Table 1 Demographic characteristics

Characteristics	*N*	%	Mean ± SD
Age			16.09 (± 0.9)
BMI			20.49 (± 2.9)
Gender			
Female	210	50.4	
Male	207	49.6	
Academic year			
First	134	32.1	
Second	123	29.5	
Third	135	32.4	
Fourth	25	6	
Physical activity level			
Sufficient	135	32.4	
Low	191	45.8	
Least	91	21.8	
Weekly energy expenditure estimate (MET-mn/week)			2534.58 (±2371.31)
Sitting period (minutes/day)			424.93 (±280.96)

compared with the level of physical activity, sitting hours, and gender, it was observed that males had more intense activity and there was a significant difference between males and females ($p = 0.001$) (Fig. 1). No relationship was found between academic year and physical activity level ($p = 0.87$).

When the evaluations made for the lifetime, last 12 months, the last month and the day of assessment were compared with the presence of MSSs, a statistically significant difference was found between experiencing lifetime and last year upper/low back pain and the participants' physical activity levels and sitting time a day ($p = 0.02$, $p = 0.009$).

However, no difference was found between experiencing pain during the last year/month and on the day of assessment and physical activity. There was also no statistically significant relationship observed between experiencing pain in other regions of the body and physical activity levels (Table 4).

When the other factors that may affect upper/low back pain were assessed, we saw that there is no significant correlation between the other factors (gender, BMI, academic year, and age of the participants) and upper/low back pain (Table 5).

Discussion

This study showed that the lifetime, 12-month, and daily prevalence rates of MSD among high school students were high. The most common musculoskeletal system pain came from the spine (neck, upper back, lower back). A correlation was found between upper/low back pain and physical inactivity.

The frequency of MSDs and other subjective health complaints seems to increase in adolescents (Alricsson et al. 2006; Hanvold et al. 2010). Our study showed that more than 57%

Table 2 Prevalence, duration, location, and frequency of musculoskeletal symptoms

	Lifetime (%)	12 months (%)	1 month (%)	Point (%)	Continuous (%)	Often (%)	Rarely (%)
Neck	28.8	19.7	17.0	10.8	4.1	10.8	13.9
Shoulder	17.5	11.8	10.1	6.7	2.2	6.5	8.6
Upper back	29.7	16.5	15.3	9.1	4.3	8.9	12.9
Elbow	2.9	1.7	1.4	1.2	0.01	0.5	2.4
Wrist/hand	11.0	1.4	4.6	2.2	0.5	4.3	6.5
Lower back	26.9	16.3	13.2	8.4	4.1	8.6	11.0
Hip/leg	5.5	13.8	3.4	1.9	1.2	1.7	2.6
Knee	17	13.2	9.4	5.3	3.4	6.5	6.7
Ankle/ft	15.8	10.3	7.7	5.3	1.9	7.7	7.4

Point: the day the assessment was performed

Table 3 Students who reported body pain during the last 1 year

Location	Female: *n* (%)	Male: *n* (%)	*P*-value
Upper back	33 (15)	42 (20)	ns
Neck	37 (17)	34 (16)	ns
Low back	35 (16)	33 (15)	ns
Knee	31 (14)	24 (11)	ns
Shoulder	30 (14)	19 (9)	ns
Ankle	24 (11)	19 (9)	ns
Hip	5 (2)	11 (5)	ns
Elbow	3 (1)	4 (4)	ns

ns = not significant

of students complained of musculoskeletal pain during the past year. Hence, neither age nor academic grade of the student had a significant influence on the pain. Fifty-two percent of the students that complained of musculoskeletal pain in the past year were girls. Interestingly, others have also shown that females regardless of age have significantly more back pain than males (Barnekow et al. 1998; Sallis 1993; Brattberg 1994; Undén and Elofsson 2001). Myrtveit et al. reported that neck and shoulder pain were common in adolescent girls (Myrtveit et al. 2014). Alricson et al. also showed that high school girls had worse general health profiles (Alricsson et al. 2006). In accordance with the literature, musculoskeletal pain, especially neck, low back, and shoulder pain, is frequently higher among girls. It is possible that the difference in pain reporting between male and female is due to the fact that females are more sensitive to pain and reporting it more easily than men. Furthermore, understanding how "pain feels" can be different between males and females (Cho et al. 2003).

We observed in our study that high school students did not have enough physical activity. The mean weekly energy consumption linked to physical activity as calculated according to the IPAQ was found to be 1543 (± 1949) MET-min/week in our study. Thirty-three percent of students had sufficient levels of activity, 46% exhibited low levels, and 22% were inactive. Also, female students had lower physical activity levels when compared to male students.

General epidemiological findings showed a difference in gender regarding physical activity. Boys are more active than girls. Usually, physical activity declines with increasing age, with males declining around 3% per year whereas females decline about 7% per year (Brattberg 1994; Undén and Elofsson 2001; Myrtveit et al. 2014; Cho et al. 2003; Mechelen et al. 2000). This suggests that lack of physical activity in youth and specifically in women can lead to increased obesity risk (Sallis 1993). In our study, the BMIs of the students were generally within normal limits. However, as one of the limitations of the study, students were assessed cross-sectionally, and it was necessary to follow participants in order to observe the effects of sedentary lifestyles on the BMI.

In our study, we found a correlation between upper and lower back pain, and low levels of physical activity. This suggests that minimal physical activity may result in numerous musculoskeletal system problems. Furthermore, low levels of physical activity in combination with long durations of inappropriate postures, can lead to pain in spinal region. Inappropriate posture due to computer or screen-based

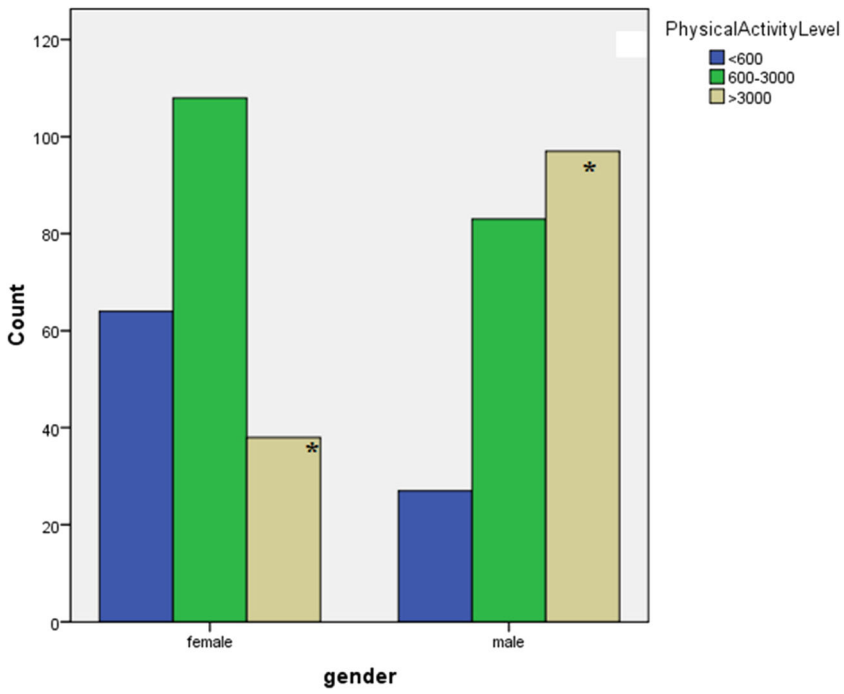

Fig. 1 * Comparison of the levels of physical activity and sitting hours between males and females ($p = 0.001$)

Table 4 Impact of physical activity on symptoms, 12 months or 1 month previously, and point

Physical activity	Least		Low		Sufficient		*P*
	N	%	*N*	%	*N*	%	
Neck[1]							0.81
Yes	17	20.7	36	43.9	29	21.5	
No	74	22.1	155	46.3	106	78.5	
Neck[2]							0.95
Yes	15	16.5	32	16.8	24	33.8	
No	76	83.5	159	45.1	111	82.2	
Neck[3]							0.68
Yes	11	12.1	22	11.5	12	26.7	
No	80	87.9	169	88.5	123	33.1	
Shoulder[1]							0.27
Yes	13	14.3	25	13.1	11	8.1	
No	78	85.7	166	86.9	124	91.9	
Shoulder[2]							0.66
Yes	10	11.0	21	11.0	11	8.1	
No	81	89.0	170	89.0	124	91.9	
Shoulder[3]							0.63
Yes	8	8.8	11	5.8	9	6.7	
No	83	91.2	180	94.2	126	93.3	
Upper back[1]							0.04*
Yes	22	24.2	25	13.1	28	20.7	
No	69	75.8	166	86.9	107	79.3	
Upper back[2]							0.25
Yes	20	22.0	27	14.1	24	17.8	
No	71	78.0	164	85.9	111	82.2	
Upper back[3]							0.32
Yes	10	11.0	16	6.8	15	11.1	
No	81	89.0	178	93.2	120	88.9	
Elbow[1]							0.65
Yes	2	2.2	2	1.0	3	2.2	
No	89	97.8	189	99.0	132	97.8	
Elbow[2]							0.19
Yes	2	2.2	2	1.0	2	23.1	
No	89	97.8	189	99.0	133	11.3	
Elbow[3]							0.45
Yes	2	2.2	1	0.5	2	1.5	
No	89	97.8	190	99.5	133	98.5	
Wrist/hand[1]							0.65
Yes	2	2.2	2	1.0	3	2.2	
No	89	97.8	189	99.0	132	97.8	
Wrist/hand[2]							0.74
Yes	2	2.2	2	1.0	2	1.5	
No	89	97.8	189	99.0	133	98.5	
Wrist/hand[3]							0.45
Yes	2	2.2	1	0.5	2	1.5	
No	89	97.8	190	99.5	133	98.5	
Lower back[1]							0.01*
Yes	36	39.6	48	25.1	31	23.0	
No	55	60.4	143	74.9	104	77.0	
Lower back[2]							0.45
Yes	13	14.3	21	11.0	21	15.6	
No	78	85.7	170	89.0	114	84.4	
Lower back[3]							0.19
Yes	9	9.9	11	5.8	15	11.1	
No	82	90.1	180	94.2	120	88.9	
Hip/leg[1]							0.28
Yes	2	2.2	6	3.1	8	5.9	
No	89	97.8	185	96.9	127	94.1	
Hip/leg[2]							0.63
Yes	2	2.2	6	3.1	6	4.4	
No	89	97.8	185	96.9	129	95.6	
Hip/leg[3]							0.18
Yes	1	1.1	2	1.0	5	3.7	
No	90	98.9	189	99.0	130	96.3	
Knee[1]							0.81
Yes	13	14.3	23	12.0	19	14.1	
No	78	85.7	168	88.0	116	85.9	
Knee[2]							0.25
Yes	6	6.6	16	8.4	17	12.6	

Table 4 (continued)

Physical activity	Least		Low		Sufficient		*P*
	N	%	*N*	%	*N*	%	
No	85	93.4	175	91.6	118	87.4	
Knee[3]							0.06
Yes	4	4.4	6	3.1	12	8.9	
No	87	95.6	185	96.9	123	91.1	
Ankle/ft[1]							0.85
Yes	8	8.8	20	10.5	15	11.1	
No	83	91.2	171	89.5	120	88.9	
Ankle/ft[2]							0.50
Yes	5	5.5	14	7.3	13	9.6	
No	86	94.5	177	92.7	122	90.4	
Ankle/ft[3]							0.67
Yes	4	4.4	9	4.7	9	6.7	
No	87	95.6	182	95.3	126	93.3	

1: 12 months previously; 2: 1 month previously; 3: The day the assessment was performed

Statistically significant: * $p < 0.05$; ** $p < 0.01$

activities increases the risk of poor posture and neck/back pain. Previously, reports have shown that static computer work is an independent risk factor for adolescent musculoskeletal pain (Hakala et al. 2006). Also computer-based games are playing an important role in the development of inappropriate posture leading to musculoskeletal pain in adolescents. Furthermore, insufficient recovery after local muscle fatigue related to static work and repetitive movements could be a possible cause of musculoskeletal pain (Sjøgaard et al. 2000).

Sufficient physical activity will lead to reduced pain, strengthened weak muscles, and decreased mechanical load on vertebral structures, and help with posture (Jackson and Brown 1983). Moreover, active and passive exercises increase blood circulation, reduce muscle tensio, and preserve joint movement, which will lead to reduction in pain. Previously, studies have shown that strengthening and stretching exercises can ensure the amelioration of function and reduce nonspecific spinal pain (Hayden et al. 2005; Ardıç 2014). Kocur et al. reported that a 12-week Nordic walking training routine improved participants' shoulder mobility and reduced the tenderness in their middle trapezius, infraspinatus, and latissimus dorsi (Kocur et al. 2017). Pesco et al. noted that daily active exercises to correct poor posture are crucial to reducing upper back and neck pain. (Pesco et al. 2006). Furthermore, Crow et al. reported that isolated muscle training has a positive effect on lower back pain (Crow et al. 2011). The outcomes of our study are similar with the literature.

A study conducted in Norway showed that children who walk to school have less lower back pain than children that go to school by car or public transportation (Sjolie 2004). In our study, we found that most of the students were sitting for approximately 7 h, since most of them went to school by car or public transportation. Our regression analysis revealed a significant relationship between back pain and prolonged sitting posture.

There are many studies discussing back pain in adolescents. To the best of our knowledge, ours is the first study to evaluate the relationship of physical activity and musculoskeletal disorders by using the Nordic questionnaire among adolescents in Turkey. Epidemiological studies have shown that 20–60% of subjects with an age between 16 and 20 years have a history of back pain (Smedbråten et al. 1998; Kujala

Table 5 Regression analysis of the relationship between back pain and other factors

	Upper back pain			Low back pain		
	OR	CI 95%	*P*	OR	CI 95%	*P*
Age	1.4	0.58–5.75	0.34	1.4	0.38–5.75	0.56
Gender	.8	0.78–1.24	0.48	1.4	0.88–2.26	0.14
BMI (kg/m^2)	.9	0.89–1.02	0.65	.9	0.92–1.07	0.88
Academic year	.7	0.19–3.22	0.74	.7	0.17–2.86	0.62
Physical activity level	.7	0.53–0.98	0.040*	.7	0.52–0.99	0.045*

* statistically significant

et al. 1999; Cho et al. 2003). In our study, 35% of the females and 33% of the males had back pains. Hence, low physical activity was negatively correlated with back pain. Moreover, our results are in agreement with previously published studies.

Limitations

It must be noted that the results of this study are limited due to the use of a self-reported questionnaire, which might be affected by both the subject status of the participants and recall bias. Further, the majority of participants had a normal BMI, while there was an unequal number of male and female participants. Additionally, the study did not assess the personal, psychosocial and ergonomic risk factors that have previously been reported to increase musculoskeletal system pain.

Conclusion

The results showed a relationship between high prevalence of musculoskeletal symptoms and low physical activity levels in this adolescent population. Physical activity levels should be considered when evaluating young people with musculoskeletal disorders. Thus, to prevent chronic diseases, it is important to provide physical activity at school as well as during leisure time.

Compliance with ethical standards

Conflict of interest Author Semra Aktürk declares that she has no conflict of interest. Author Raikan Büyükavcı declares that she has no conflict of interest. Author Ümmühan Aktürk declares that she has no conflict of interest.

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

References

Alricsson M, Landstad BJ, Romild U, Werner S (2006) Self-related health, physical activity and complaints in Swedish high school students. Sci World J 6:816–826

Andersen JH, Kaergaard A, Mikkelsen S, Jensen UF, Frost P, Bonde JP, Thomsen JF (2003) Risk factors in the onset of neck/shoulder pain in a prospective study of workers in industrial and service companies. Occup Environ Med 60:649–654

Anderson JJ (2000) The important role of physical activity in skeletal development: how exercise may counter low calcium intake. Am J Clin Nutr 71:1384–1386

Ardıç F (2014) Health benefits of exercise. Turk J Phys Med Rehab 60(2): 9–14

Ariens GA, Van MW, Bongers PM, Bouter LM, Wal G (2000) Physical risk factors for neck pain. Scand J Work Environ Health 26:7–19

Barnekow M, Hedberg G, Janlert U, Jansson E (1998) Prediction of physical fitness and physical activity level in adulthood by physical performance and physical activity in adolescence — an 18-year follow-up study. Scand J Med Sci Sports 8:299–308

Barnekow T, Magerøy N, Moen BE (2007) Physical activity is associated with a low prevalence of musculoskeletal disorders in the Royal Norwegian Navy: a cross sectional study. BMC Musculoskelet Disord 8:56

Bernard BP (1997) Musculoskeletal disorders and workplace factors. A critical review of epidemiologic evidence for work-related musculoskeletal disorders of the neck, upper extremity, and low back. NIOSH, Washington, DC

Brattberg G (1994) The incidence of back pain and headache among Swedish school children. Qual Life Res 3:27–31

Briggs AM, Straker LM, Bear NL, Smith AJ (2009) Neck/shoulder pain in adolescents is not related to the level or nature of self-reported physical activity or type of sedentary activity in an Australian pregnancy cohort. BMC Musculoskelet Disord 10:87

Cho CY, Hwang IS, Chen CC (2003) The association between psychological distress and musculoskeletal symptoms experienced by Chinese high school students. J. Orthop Sports Phys Ther 33:344–353

Craig CL, Marshall AL, Sjöström M, Bauman AE, Booth ML, Ainsworth BE, Oja P (2003) International physical activity questionnaire: 12-country reliability and validity. Med Sci Sports Exerc 35:1381–1395

Crow J, Pizzari T, Buttifant D (2011) Muscle onset can be improved by therapeutic exercise: a systematic review. Phys Ther Sport 12(4): 199–209

Duppe H, Gardsell P, Johnell O, Nilsson BE, Ringsberg K (1997) Bone mineral density, muscle strength and physical activity: a population based study of 332 students aged 15–42 years. Acta Orthop Scand 68:97–103

Hakala PT, Rimpelä AH, Saarni LA, Salminen JJ (2006) Frequent computer-related activities increase the risk of neck–shoulder and low back pain in adolescents. Eur J Pub Health 16:536–541

Hanvold TN, Veiersted KB, Wærsted M (2010) A prospective study of neck, shoulder, and upper back pain among technical school students entering working life. J Adolesc Health 46(5):488–494

Hardman AE (2001) Physical activity and health: current issues and research needs. Int J Epidemiol 30:1193–1197

Hayden JA, Tulder MW, Tomlinson G (2005) Systematic review: strategies for using exercise therapy to improve outcomes in chronic low back pain. Ann Intern Med 142(9):776–785

Holth HS, Werpen HKB, Zwart JA, Hagen K (2008) Physical inactivity is associated with chronic musculoskeletal complaints 11 years later: results from the Nord-Trondelag health study. BMC Musculoskelet Disord 9:159

Huang GD, Feuerstein M, Sauter SL (2002) Occupational stress and workrelated upper extremity disorders: concepts and models. Am J Ind Med 41:298–314

Jackson CP, Brown MD (1983) Is there a role for exercise in the treatment of patients with low back pain? Clin Orthop Relat Res 179:39–45

Kahraman T, Genç A, Göz E (2016) The Nordic musculoskeletal questionnaire: crosscultural adaptation into Turkish assessing its psychometric properties. Disabil Rehabil 38:21

Kocur P, Pospieszna B, Choszczewski D, Michalowski L, Wiernicka M, Lewandowski J (2017) The effects of Nordic walking training on selected upper-body muscle groups in female-office workers: a randomized trial. Work 56(2):277–283

Kujala UM, Taimela S, Viljanen T (1999) Leisure physical activity and various pain symptoms among adolescents. Br J Sports Med 33: 325–328

Kuorinka I, Jonsson B, Kilbom A, Vinterberg H, Biering F, Andersson G, Jørgensen K (1987) Standardised Nordic questionnaires for the analysis of musculoskeletal symptoms. Appl Ergon 18:233–237

Lang T, Altman D (2013) Basic statistical reporting for articles published in clinical medical journals: the SAMPL Guidelines. In: Smart P, Maisonneuve H, Polderman A (eds) Science Editors' Handbook. European Association of Science Editors

Mechelen WV, Twisk JWR, Post GB, Snel JAN, Kemper HC (2000) Physical activity of young people: the Amsterdam longitudinal growth and health study. Med Sci Sports Exerc 32(9):1610–1616

Myrtveit SM, Sivertsen B, Skogen JC, Frostholm L, Stormark KM, Hysing M (2014) Adolescent neck and shoulder pain—the association with depression, physical activity, screen-based activities, and use of health care services. J Adolesc Health 55(3):366–372

Ozcan E, Esmaeilzadeh S, Bölükbaş N (2007) Ergonomics and prevention in work-related musculoskeletal disorders among computer users. Nobel Med 3(1):12–17

Palmer KT, Smedley J (2007) Work relatedness of chronic neck pain with physical findings—a systematic review. Scand J Work Environ Health 33:165–191

Pate RR, Pratt M, Blair SN, Haskell WL, Macera CA, Bouchard C, Kriska A (1995) Physical activity and public health. A recommendation from the Centers for Disease Control and Prevention. American College of Sports Medicine. JAMA 273(5):402–407

Pesco MS, Chosa E, Tajima N (2006) Comparative study of hands-on therapy with active exercises vs education with active exercises for the management of upper back pain. J Manip Physiol Ther 29(3): 228–235

Saglam M, Arikan H, Savci S, Inal D, Bosnak M, Karabulut E, Tokgozoglu L (2010) International physical activity questionnaire: reliability and validity of the Turkish version. Percept Mot Skills 111:278–284

Sallis JF (1993) Epidemiology of physical activity and fitness in children and adolescents. Crit Rev Food Sci Nutr 33(4–5):403–408

Sjøgaard G, Lundberg U, Kadefors R (2000) The role of muscle activity and mental load in the development of pain and degenerative processes at the muscle cell level during computer work. Eur J Appl Physiol 83:99–105

Sjolie AN (2004) Associations between activities and low back pain in adolescents. Scand J Med Sci Sports 14:352–359

Smedbråten BK, Natvig B, Rutle O (1998) Self-reported bodily pain in schoolchildren. Scand J Rheumatol 27:273–276

Sundblad GB, Jansson A, Saartok T, Renström P, Engström LM (2008) Self-rated pain and perceived health in relation to stress and physical activity among school-students: a 3-year follow-up. Pain 136:239–249

Undén AL, Elofsson S (2001) Health from the patient's point of view. How does it relate to the physician's judgement? Fam Pract 18:174–180

Yılmaz F, Şahin F, Kuran B (2006) Work related musculoskeletal disorders and therapy. Nobel Med 2(3):15–22