An inactive lifestyle and low physical fitness are associated with functional somatic symptoms in adolescents. The TRAILS study

Janssens, Karin A. M.; Oldehinkel, Albertine J.; Bonvanie, Irma J.; Rosmalen, Judith G. M.

Published in:
Journal of Psychosomatic Research

DOI:
10.1016/j.jpsychores.2014.03.008

Journal of Psychosomatic Research 76 (2014) 454–457

Contents lists available at ScienceDirect

Journal of Psychosomatic Research

An inactive lifestyle and low physical fitness are associated with functional somatic symptoms in adolescents. The TRAILS study

Karin A.M. Janssens *, Albertine J. Oldehinkel, Irma J. Bonvanie, Judith G.M. Rosmalen

Interdisciplinary Center Psychopathology and Emotion regulation, University of Groningen, University Medical Center Groningen, The Netherlands

ARTICLE INFO

Article history:
Received 9 September 2013
Received in revised form 18 March 2014
Accepted 18 March 2014

Keywords:
Medically unexplained symptoms
Youth
Physical activity

ABSTRACT

Objective: An inactive lifestyle has been associated with functional somatic symptoms (FSS), but findings are contradictory. Moreover, mediating factors in this relationship are unclear. We examined whether low physical activity was related to FSS in adolescents, and whether this association was mediated by low physical fitness.

Methods: This study was part of the Dutch longitudinal cohort study TRAILS, in which 1816 adolescents (mean age 16.3 years, SD 0.7) participated during the third (T3) and 1881 (mean age 19.1 years, SD 0.6) during the fourth (T4) assessment waves. Adolescents' exercise and sedentary behavior levels and the number of FSS were assessed by questionnaires at T3 and T4. Physical fitness (VO_2Max) was determined for 687 adolescents by a shuttle run test at T3. The association between physical activity and FSS was examined with bootstrapped linear regression analyses, adjusted for smoking and gender. In addition, bootstrapped mediation analyses were performed.

Results: A lack of exercise ($b = 0.05$, bootstrap 95%-CI: 0.01 to 0.09) and high sedentary behavior ($b = 0.10$, bootstrap 95%-CI: 0.06 to 0.14) at T3 were positively associated with FSS at T3. Since no longitudinal effects were found, shared associations were tested instead of mediation. The associations between a lack of exercise and FSS, and sedentary behavior and FSS were shared with physical fitness ($b = 0.01$, bootstrap 95%-CI: 0.010.02. and $b = 0.03$, bootstrap 95%-CI: 0.010.05).

Conclusion: An inactive lifestyle is associated with increased FSS in adolescents. Only part of this association is shared with low physical fitness.

Introduction

Functional somatic symptoms (FSS), which are, somatic complaints not fully explained by underlying organic pathology, are common among adolescents. The etiology of these symptoms is still poorly understood, but it is assumed that the symptoms are the result of interacting biological, psychological, and social factors [1].

Several studies have indicated a role of physical inactivity in the development of these symptoms [2–4], but not all studies showed such an association [5]. In addition, the direction of the relationship between physical inactivity and FSS is not well established. Some studies found an inactive lifestyle to result in FSS [3,4], whereas others found that adolescents who are suffering from somatic symptoms become inactive [6], and some studies did not find a longitudinal association between FSS and physical inactivity at all [7,8].

Moreover, factors explaining the association between physical inactivity and FSS are unclear. Poor physical fitness is often assumed to account for most of the association. However, studies on the effects of graded-exercise therapy and cognitive behavior therapy on chronic fatigue showed that although these therapies enhance physical activity, the effectiveness of these therapies on fatigue was not explained by an increase in physical fitness [9,10]. These studies were performed in clinical samples. To the best of our knowledge, previous research on physical inactivity and FSS in the general population never examined the role of physical fitness. Hence, it is unknown whether physical fitness is of importance in the association between physical inactivity and FSS in the general population.

Thus, the direction of the association between an inactive lifestyle and FSS is unclear, as well as factors that mediate this association. The aim of the current study is to examine the direction of the association between an inactive lifestyle and FSS, and mediating factors in this association. We hypothesize that a) physical inactivity is associated with FSS; and b) the association between physical inactivity and FSS is bidirectional: physical inactivity predicts the course of

Abbreviations: FSS, functional somatic symptoms; YSR, Youth Self-Report; ASR, Adolescent Self-Report; VO_2Max, maximal oxygen consumption.

* Corresponding author at: Interdisciplinary Center Psychopathology and Emotion regulation, University of Groningen, University Medical Center Groningen, CC 72, PO Box 30001, 9700 RB Groningen, The Netherlands. Tel.: +31 50 3610460; fax: +31 50 361 9722.

E-mail address: k.a.m.janssens@umcg.nl (K.A.M. Janssens).

http://dx.doi.org/10.1016/j.jpsychores.2014.03.008
0022-3999/

FSS, and FSS determine the amount of physical inactivity; c) this association is mediated by a low physical fitness.

Methods

Sample

This study is part of TRAILS (Tacking Adolescents' Individual Lives Survey), a large prospective population study of Dutch adolescents with bi- or triennial measurements from age 11 to at least age 25. TRAILS participants were selected from 5 municipalities in the north of The Netherlands, including both urban and rural areas. All children born between October 1, 1989 and September 30, 1990, (first two municipalities) or October 1, 1990, and September 30, 1991, (last 3 municipalities) were eligible for inclusion, provided that their schools were willing to co-operate and that they were able to participate in the study. More than 90% of the schools, accommodating 3145 children, agreed to participate in the study. A small proportion (6.7%) of these children was excluded because of mental or physical incapability or language problems. Of the remaining 2935 children, 2230 (76.0%; mean age, 11.09 years; SD = 0.56 years; age range, 10–12 years; 50.8% girls) were enrolled in the study (i.e., both child and parent agreed to participate). Teacher reports, which were available for 40.7% of the non-responders, revealed that they did not differ from responders in the prevalence of problem behavior nor in associations between sociodemographic variables and mental health outcomes, but non-responders were more likely to be boys, to have a low socioeconomic background, and to perform poorly at school [11].

Thus far, four assessment waves of TRAILS have been completed, running from March 2001 to July 2002 (T1), September 2003 to December 2004 (T2), September 2005 to December 2007 (T3), and September 2009 to October 2010 (T4). During T1, 2230 children were enrolled in the study (for more details about attrition, see [11–13]), of whom 1816 (83.0%) participated at T3, and 1881 (84.3%) at T4. The time frame between T3 and T4 was on average 2.8 years (34 months; SD = 6.4; range 11–58). The mean age of the participants was 16.3 (SD = 0.7) during T3 and 19.1 (SD = 0.6) during T4. The percentage of girls was 52.1% during T3, and 52.3% during T4.

TRAILS adolescents were invited to perform a physical fitness test at T3 when their school was willing to participate. Adolescents were located over at least 119 schools; the schools of 57 adolescents were unknown. Sixty-nine of the schools (57.9%), accommodating 1781 (79.8%) of all TRAILS adolescents, participated in the physical fitness test. Of these 1781 TRAILS adolescents, 722 (40.5%) performed the test, and valid performance data were available for 687 adolescents.

The protocol was approved by the Central Committee on Research Involving Human Subjects (CCMO). All participating adolescents and their parents gave informed consent.

Physical exercise and sedentary behavior

During the third assessment wave, adolescents reported how many times a week they participated in physical exercise outside school for at least 1 h. They answered on a 5 point scale ranging from "almost never" to "more than 5 times". Adolescents who answered that they almost never exercised outside school were considered to have a lack of physical exercise. In order to assess sedentary lifestyle, adolescents answered questions about the number of hours they watched television or video; and about the number of hours they spent behind their computer. Both questions were asked for weekdays and weekend days, resulting in four answers. The response categories ranged from 0 (= not at all) to 8 (= 7 h a day or more). An average daily number of hours spent watching television or video or using the computer was computed. In line with previous studies [4], cut-off scores were used instead of continuous scores, since we did not expect the association between activity level and FSS to be linear. Adolescents who had an average sedentary behavior score higher than 4 h a day were considered high on sedentary behavior.

Physical fitness (VO_2Max)

A 20 m shuttle run test was used to assess physical fitness. The shuttle run test is a maximal field test, which has been validated in children and adolescents [14,15]. Participants had to run back and forth on a 20 m course and pivot on the 20 m line, while keeping the pace with audio signals emitted from a pre-recorded compact disk. The initial speed was 8 km/h and the speed increased with 0.5 km/h every minute. In a subsample of 272 (41.6%) participants, heart rate monitoring was performed using Polar Team System series 1 (Polar, Kempele, Finland) to examine whether adolescents gave a maximal performance. Adolescents were considered to have given a maximum performance when their heart rate was higher than 185 beats/min. Five participants (1.8%) scored below this criterion (range 171–184 beats/min). Performance on the test did not differ between participants wearing a heart rate monitor and participants who did not (respectively 46.3 SD 7.4, 46.3 SD 6.8; $p = 0.21$). The estimated maximal oxygen consumption (VO_2Max) was calculated using the following equation: $VO_2Max = 31.025 + (3.238 * \text{Speed}) - (3.248 * \text{Age}) + 0.1536 * (\text{Speed} * \text{Age})$ [14].

FSS

FSS were assessed with the Somatic Subscale of the Youth Self-Report (YSR) at T3 and the Adolescent Self-Report (ASR) at T4 [16]. This subscale contains items referring to somatic complaints without a medical cause (i.e. pain, headache, stomachache, nausea, vomiting, eye problems, and skin problems) or without an obvious reason (i.e. dizziness and overtiredness). Factor analyses showed that the items 'eye problems' and 'skin problems' had low loadings [17]. These items were therefore excluded. Participants were asked if they had experienced these complaints in the last six months on a three-point scale ranging from 'never' (0), 'sometimes or a bit' (1) to 'often or a lot' (2). The mean item scores at T3 and T4 were computed for the seven items with outcomes ranging between 0 (no FSS at all) and 2 (all FSS often or a lot).

Items were presented differently in the ASR online questionnaire and the paper version: in the online version the screening question 'physical complaints without a known medical cause' was included. If participants filled out that they had 'never' experienced physical complaints without a medical cause, the separate items (i.e. pain, headache, stomachache, nausea, and vomiting without a known medical cause) were not shown and automatically set to 'never'. This resulted in substantially lower FSS scores in adolescents who filled out the online questionnaire in comparison to adolescents who filled out the paper questionnaire. Therefore, we included 'type of questionnaire' as a covariate in our longitudinal analyses concerning FSS at T4. Since the majority of adolescent (82.5%) filled out the online questionnaire, FSS scores were substantially lower at T4 than at T3.

Statistical analyses

Linear regression analyses were used to examine whether a lack of physical exercise and high sedentary behavior were associated with FSS; as well as the direction of these associations. First, we examined whether a lack of exercise and high sedentary behavior at T3 predicted FSS at T4, adjusted for FSS at T3. Second, we studied whether FSS at T3 predicted a lack of exercise at T4, adjusted for a lack of exercise at T3. The longitudinal effect of FSS on sedentary behavior was not tested, since the assessment of sedentary behavior at T3 was not comparable to the assessment at T4. Because FSS were not normally distributed, bootstrapping was used. In bootstrapping, the sample data are treated as the population from which repeated samples (called bootstrap samples) are taken with replacement. Each bootstrap sample resulted in a parameter estimate, and these were used to calculate a bootstrap 95%-confidence interval (CI) [18]. Ten thousand bootstrap samples were performed per analysis. A bootstrapping procedure was also used to examine whether physical fitness mediated the association between physical inactivity and FSS, again with 10,000 bootstrap samples [19]. An effect was considered significant if the bootstrap 95%-CI did not include zero. All analyses were adjusted for gender and smoking at T3, since they have been associated with both FSS [20,21] and physical inactivity [22, 23]. Smoking was defined as being a daily smoker (yes or no).

Results

Descriptive statistics

The percentage of girls, percentage of smokers, and mean levels of sporting and sedentary behavior and FSS of the total sample at T3 and the subsample of adolescents who performed the shuttle run test at T3 are given in Table 1. Adolescents participating in the physical fitness tests differed in many aspects from other TRAILS adolescents, and were in general much healthier (Table 1). The mean score on the shuttle run test was 68.5 laps; the performance on the shuttle run test ranged from 7 to 156 laps.

Cross-sectional and longitudinal associations between physical activity and FSS

Lack of physical exercise ($b = 0.05$, bootstrap 95%-CI = 0.006 to 0.09) and high sedentary behavior ($b = 0.10$, bootstrap 95%-CI = 0.06 to 0.14) were positively associated with FSS at T3. So adolescents who reported not to exercise scored on average 0.05 points higher on the FSS scale at T3 than adolescents who reported to exercise; and adolescents who reported much sedentary behavior scored on average 0.10 points higher on this scale than adolescents who reported little sedentary behavior. Lack of physical exercise ($b = -0.03$, bootstrap 95%-CI = −0.07 to 0.01) and high sedentary behavior ($b = 0.02$, bootstrap 95%-CI = −0.04 to 0.05) at T3 were both not associated with FSS at T4, when adjusted for FSS at T3. Moreover, FSS at T3 did not predict lack of physical exercise at T4 ($b = 0.12$, bootstrap 95%-CI = −0.09 to 0.34), when adjusted for lack of physical exercise at T3.

Physical fitness

Since no longitudinal effect of physical inactivity on FSS was found, mediation tests could only be performed on cross-sectional data. Hence, we were only able to test for shared associations. Lack of physical exercise ($b = -3.48$, bootstrap 95%-CI = −4.84 to −2.04) and high sedentary behavior ($b = -1.34$, bootstrap 95%-CI = −2.63 to −0.02) were significantly associated with low physical fitness at T3. In turn, physical fitness was significantly ($b = -0.005$, bootstrap 95%-CI = −0.008 to −0.001) associated with FSS at T3. Bootstrapped analyses showed that the association between lack of physical exercise and FSS was shared with physical fitness ($b = 0.03$, bootstrap 95%-CI = 0.01 to 0.05), and the same was true for the association between sedentary behavior and FSS ($b = 0.04$, bootstrap 95%-CI = 0.02 to 0.06).

Discussion

This population-based study suggests that a lack of exercise, high sedentary behavior, and low physical fitness are associated with more FSS in adolescents. Moreover, the cross-sectional associations between a lack of exercise and FSS, and high sedentary behavior and FSS were partially shared with the association between low physical fitness and FSS. No longitudinal associations were found between physical activity level and FSS.

One major strength of this study is that it is, to the best of our knowledge, the first study that took physical fitness (i.e. VO_2Max) into account when studying the association between physical activity and FSS. We were able to show that physical fitness was associated with FSS and that this association was partially shared with the association between physical activity and FSS. Another strength of this study is that we tested whether adolescents performed a maximum shuttle run test. This makes it likely that the low physical fitness truly reflected physical fitness capacity and diminishes the risk that adolescents were just not willing to continue with the test any longer. A final strength is that the longitudinal design enabled studying the direction of the association between FSS and physical activity.

One limitation of this study is that only a subgroup of our general population cohort participated in the shuttle run test. Adolescents who participated differed in many aspects from adolescent that did not participate, although differences were only small. Differences were probably due to a selection bias: healthy and sportive adolescents might have been more willing to participate in the experiment than adolescents who were unhealthy and did not like sport. Moreover, adolescents who suffered from (severe) FSS were under-represented in the participating subsample. This might have given an underestimation of the association between physical fitness and FSS, since this association might have been especially evident in adolescents suffering from severe symptoms.

Another limitation is that the length between the waves (2–3 years) was probably too long to establish the direction of the association between physical inactivity and FSS. Since no insight in the direction of this association was obtained, we were not able to test mediating factors in this association, and could only test for shared associations. Studies with shorter time frames between subsequent waves are needed to examine both the direction of the association between physical inactivity and FSS, and the mediating factors in this association.

We found that a lack of physical exercise and high sedentary behavior were associated with FSS. This is in line with most previous studies [2,4,24]. We did not find physical inactivity to predict the course of FSS. This is in line with a study of Dunn et al. [7] who did not find a role of physical activity in the developmental pattern of pain in a general population cohort of adolescents, and a study by Goodwin et al. who did not found a predictive effect of extremes of physical activity during childhood on chronic fatigue syndrome in adulthood [8]. In contrast, other studies found that physical inactivity increased the level of FSS during adolescence [3,4]. These differences might be explained by the shorter time frames between the assessment waves in those studies

Table 1
Characteristics of the total sample and of the subsample that underwent the shuttle run test.

	Total sample		Shuttle run test subsample	
	Valid N	Mean (SD) or percentage	Valid N	Mean (SD) or percentage
Female	1819	52.3%	687	48.5%*
Age	1819	16.3 (0.7)	686	16.0 (0.5)*
Watching television (h Monday–Friday)	1630	1.9 (1.4)	678	1.7 (1.3)*
Watching television (h weekend)	1620	2.5 (1.6)	676	2.3 (1.5)*
Computer (h Monday–Friday)	1628	2.3 (1.8)	677	2.1 (1.7)*
Computer (h weekend)	1619	2.9 (2.0)	675	2.7 (1.9)*
Sport T3 (times)	1661	2.0 (1.4)	679	2.2 (1.3)*
Sport T4 (times)	1714	1.5 (1.4)	631	1.7 (1.3)*
Smoking (daily)	1657	17.2%	687	12.1%*
Body mass index	1593	21.3 (3.3)	676	20.8 (2.7)*
FSS at T3[a]	1594	0.34 (0.34)	658	0.31 (0.32)*
FSS at T4[a]	1680	0.20 (0.31)	626	0.17 (0.28)*

[a] Mean item score of somatic items of the YSR (at T3) or the ASR (at T4), which could range from 0 to 2.
* χ^2 test or T-test indicates that this score significantly ($p < 0.05$) differs from that of adolescents who did not undergo the shuttle run test.

(i.e. one to two years). As mentioned, the time frame between the assessment waves in our study (i.e. 2.8 years) might have been too long to find a longitudinal effect of physical activity.

The associations between lack of physical exercise and FSS, and sedentary behavior and FSS were partially shared with low physical fitness. However, only a small part of these associations was shared. A possible explanation for these small shared associations is that we examined a spectrum of FSS instead of specific symptoms that are potentially more exercise-related, like overtiredness. However, exploratory analyses in our sample show that the association of physical inactivity and physical fitness with overtiredness was comparable to that with the spectrum of FSS (results not shown). This is in line with intervention studies that found that the effect of graded-exercise therapy or cognitive behavioral therapy on chronic fatigue is not explained by an improvement in physical condition [9,10]. Therefore, other factors should be examined that could explain the associations between physical inactivity and FSS. Loneliness might be such a factor, since adolescents who are physically inactive and/or spend much time on their television or computer are more likely to suffer from loneliness than adolescents who are physically active and/or spend less time on their television or computer [25]; and loneliness has been associated with FSS [26]. Another factor might be depression. Recent TRAILS' studies showed that physical activity level predicts change in depressive symptoms [27], and that depressive symptoms are risk factors for FSS [28].

Thus, this study suggests that lack of physical exercise and high sedentary behavior are positively associated with FSS in adolescents. However, the direction of these associations could not be established. The associations between a lack of physical exercise and FSS and high sedentary behavior and FSS were only partially shared with the association between poor physical fitness and FSS.

Sources of funding

The funding sources had no role in study design; in the collection, analysis and interpretation of data; in the writing of the report; and in the decision to submit the article for publication.

Competing interest statement

The authors have no competing interests to report.

Acknowledgment

This research is part of the TRacking Adolescents' Individual Lives Survey (TRAILS). Participating centers of TRAILS include various departments of the University Medical Center and University of Groningen, the Erasmus University Medical Center Rotterdam, the University of Utrecht, the Radboud Medical Center Nijmegen, and the Parnassia Bavo group, all in The Netherlands. TRAILS has been financially supported by various grants from the Netherlands Organization for Scientific Research (NWO), ZonMW, GB-MaGW, the Dutch Ministry of Justice, the European Science Foundation, BBMRI-NL, the participating universities, and Accare Center for Child and Adolescent Psychiatry. We are grateful to all adolescents, their parents, and teachers who participated in this research, and to everyone who worked on this project and made it possible.

References

[1] Beck JE. A developmental perspective on functional somatic symptoms. J Pediatr Psychol 2008;33:547–62.
[2] Alricsson M, Domalewski D, Romild U, Asplund R. Physical activity, health, body mass index, sleeping habits and body complaints in Australian senior high school students. Int J Adolesc Med Health 2008;20:501–12.
[3] ter Wolbeek M, van Doornen LJ, Kavelaars A, Heijnen CJ. Predictors of persistent and new-onset fatigue in adolescent girls. Pediatrics 2008;121:e449–57.
[4] Viner RM, Clark C, Taylor SJ, Bhui K, Klineberg E, Head J, et al. Longitudinal risk factors for persistent fatigue in adolescents. Arch Pediatr Adolesc Med 2008;162:469–75.
[5] Huang Y, Katz BZ, Mears C, Kielhofner GW, Taylor R. Postinfectious fatigue in adolescents and physical activity. Arch Pediatr Adolesc Med 2010;164:803–9.
[6] Konijnenberg AY, Uiterwaal CSPM, Kimpen JLL, van der Hoeven J, Buitelaar JK, Graeff-Meeder ERD. Children with unexplained chronic pain: substantial impairment in everyday life. Arch Dis Child 2005;90:680–6.
[7] Dunn KM, Jordan KP, Mancl L, Drangsholt MT, Le Resche L. Trajectories of pain in adolescents: a prospective cohort study. Pain 2011;152:66–73.
[8] Goodwin L, White PD, Hotopf M, Stansfeld SA, Clark C. Psychopathology and physical activity as predictors of chronic fatigue syndrome in the 1958 British birth cohort: a replication study of the 1946 and 1970 birth cohorts. Ann Epidemiol 2011;21:343–50.
[9] Wiborg JF, Knoop H, Stulemeijer M, Prins JB, Bleijenberg G. How does cognitive behaviour therapy reduce fatigue in patients with chronic fatigue syndrome? The role of physical activity. Psychol Med 2010;40:1281–7.
[10] Moss-Morris R, Sharon C, Tobin R, Baldi JC. A randomized controlled graded exercise trial for chronic fatigue syndrome: outcomes and mechanisms of change. J Health Psychol 2005;10:245–59.
[11] de Winter AF, Oldehinkel AJ, Veenstra R, Brunnekreef JA, Verhulst FC, Ormel J. Evaluation of non-response bias in mental health determinants and outcomes in a large sample of pre-adolescents. Eur J Epidemiol 2005;20:173–81.
[12] Huisman M, Oldehinkel AJ, de Winter A, Minderaa RB, de Bildt A, Huizink AC, et al. Cohort profile: The Dutch TRacking Adolescents Individual Lives Survey; TRAILS. Int J Epidemiol 2008;37:1227–35.
[13] Nederhof E, Jorg F, Raven D, Veenstra R, Verhulst FC, Ormel J, et al. Benefits of extensive recruitment effort persist during follow-ups and are consistent across age group and survey method. The TRAILS study. BMC Med Res Methodol 2012;12:93.
[14] Leger LA, Mercier D, Gadoury C, Lambert J. The multistage 20 metre shuttle run test for aerobic fitness. J Sports Sci 1988;6:93–101.
[15] van Mechelen W, Hlobil H, Kemper HC. Validation of two running tests as estimates of maximal aerobic power in children. Eur J Appl Physiol Occup Physiol 1986;55:503–6.
[16] Achenbach TM, Dumenci L, Rescorla LA. DSM-oriented and empirically based approaches to constructing scales from the same item pools. J Clin Child Adolesc Psychol 2003;32:328–40.
[17] Janssens KA, Klis S, Kingma EM, Oldehinkel AJ, Rosmalen JG. Predictors for persistence of functional somatic symptoms in adolescents. J Pediatr 2014. http://dx.doi.org/10.1016/j.jpeds.2013.12.003.
[18] Wright BC, London K, Field AP. Using bootstrap estimation and the plug-in principle for clinical psychology data. J Exp Psychopathol 2011;2:252–70.
[19] Preacher KJ, Hayes AF. Asymptotic and resampling strategies for assessing and comparing indirect effects in multiple mediator models. Behav Res Methods 2008;40:879–91.
[20] Janssens KAM, Rosmalen JG, Ormel J, Verhulst FC, Hunfeld JA, Mancl LA, et al. Pubertal status predicts back pain, overtiredness, and dizziness in American and Dutch adolescents. Pediatrics 2011;128:553–9.
[21] Paananen MV, Taimela SP, Auvinen JP, Tammelin TH, Kantomaa MT, Ebeling HE, et al. Risk factors for persistence of multiple musculoskeletal pains in adolescence: a 2-year follow-up study. Eur J Pain 2010;14:1026–32.
[22] Rangul V, Holmen TL, Bauman A, Bratberg GH, Kurtze N, Midthjell K. Factors predicting changes in physical activity through adolescence: the Young-HUNT Study, Norway. J Adolesc Health 2011;48:616–24.
[23] Slater A, Tiggemann M. Gender differences in adolescent sport participation, teasing, self-objectification and body image concerns. J Adolesc 2011;34:455–63.
[24] ter Wolbeek M, van Doornen LJ, Kavelaars A, Tersteeg-Kamperman MD, Heijnen CJ. Fatigue, depressive symptoms, and anxiety from adolescence up to young adulthood: a longitudinal study. Brain Behav Immun 2011;25:1249–55.
[25] Page RM, Tucker LA. Psychosocial discomfort and exercise frequency: an epidemiological study of adolescents. Adolescence 1994;29:183–91.
[26] Lohre A. The impact of loneliness on self-rated health symptoms among victimized school children. Child Adolesc Mental Health 2012;6:20.
[27] Stavrakakis N, de Jonge P, Ormel J, Oldehinkel A. Bidirectional prospective associations between physical activity and depressive symptoms. The TRAILS study. J Adolesc Health 2012;50:503–8.
[28] Janssens KAM, Rosmalen JGM, Ormel J, van Oort FVA, Oldehinkel AJ. Anxiety and depression are risk factors rather than consequences of functional somatic symptoms in a general population of adolescents: the TRAILS study. J Child Psychol Psychiatry 2010;51:304–12.