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Correlates of weekday compliance to physical activity recommendations in Swiss youth non-compliant in weekend days

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ABSTRACT

Some children are inactive on weekends but active on weekdays. Correlates of such behavior remain to be clarified. We assessed school, out-of-school and family correlates of compliance with physical activity (PA) recommendations during weekdays among weekend non-compliant youth in Switzerland. Cross-sectional data collected in 2013–2015 from the SOPHYA study. PA was objectively measured during one week using waist-worn accelerometers. Compliance with PA recommendations (≥ 60 min/day of moderate-to-vigorous PA) was assessed separately for weekend and weekdays. Data on school sport, transport to school, sports club participation, household income, parent's PA and education were collected by phone interview and questionnaires. Data from 540 youth (316 girls) aged 6–16 years were available for analysis. Participants who were compliant to recommendations during weekdays were more frequently boys (50.3% *vs.* 31.4%, $p < 0.001$), more often participated in sports club (73.3% *vs.* 64.3%, $p = 0.024$), and were more prone to adopt active transport to school (75.8% *vs.* 62.0%, $p = 0.001$) than non-compliers. Multivariable adjustment showed male gender [odds ratio and (95% confidence interval): 4.30 (2.71–6.81)], sports club participation [1.91 (1.21–3.02)], and PA-active parent [1.98 (1.20–3.28)] were significantly associated with weekday compliance. Being a male, a sports club participant and having a physically active parent significantly increase compliance with PA recommendations during weekdays among Swiss youth who are inactive on weekends.

1. Introduction

The beneficial effects of regular physical activity (PA) in youth are well established (Poitras et al., 2016). According to the World Health Organization (WHO) recommendations, youth should spend at least 60 min per day in moderate-to-vigorous intensity physical activity (MVPA) to maintain a healthy cardiorespiratory and metabolic risk profile (World Health Organization, 2010). However, in industrialized countries, a significant proportion of youth fail to reach these recommendations (Verloigne et al., 2012), and while interventions to increase their PA levels are often not effective (van Sluijs et al., 2011a). In order to increase PA levels in this population, a better understanding of PA correlates is necessary.

Adopting active transport to school (Lee et al., 2008), and participating in school sports and sports club (Stuart et al., 2011) are related to higher PA levels in youth. Factors such as parent's socioeconomic status, PA habits and educational level are also positively associated with PA levels in children (Stuart et al., 2011). Most of these associations relate to a higher compliance with PA recommendations (Guinhouya et al., 2009; Butcher et al., 2008; Telford et al., 2016). In a meta-analysis, Brooke and colleagues found that youth are more active on weekdays than weekend days, and suggested that future research should explore time-specific correlates of PA (Brooke et al., 2014). Indeed, PA correlates may differ within week segments (Corder et al., 2013; McMinn et al., 2013; Bürgi and de Bruin, 2016). For example, parental rules on child's PA behavior influence after-school PA levels, whereas other family factors seem to be more important during weekends (McMinn et al., 2013). To date, little is known about correlates' distribution throughout the week. The existent literature is also limited since: (i) it mainly focuses on parental (Vander Ploeg et al., 2013) or

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environmental factors (Bürgi and de Bruin, 2016), (ii) only includes children (Pereira et al., 2017; van Sluijs et al., 2011b), (iii) or describes the correlates in relation to amounts of PA and not compliance with PA recommendations (Fuemmeler et al., 2011; Fairclough et al., 2012).

During weekdays, school attendance reduces inequalities in PA levels (Lamprecht et al., 2015) partly due to compulsory school sport lessons. Conversely, during weekends, PA behaviors tend to vary due to lower constraints. Indeed, Bürgi and de Bruin (Bürgi and de Bruin, 2016) combined Global Positioning System and accelerometry, and demonstrated that Swiss youth spend much of their weekend time at home and practice little PA. Based on their findings they formulated recommendations for interventions aiming at increasing weekend PA (Bürgi and de Bruin, 2016). However, weekday interventions aiming to increase PA in youth who are inactive during the weekend are also of interest. Indeed, youth tend to be less active during weekends (Brooke et al., 2014), and this regards mostly obese youth (Aires et al., 2007). Hence, characterizing youth who are inactive during the weekend and exploring what makes them active during the week will allow further tailoring of interventions toward those most in need, *i.e.* youth whom are inactive throughout the week.

Therefore, the aim of this study was to assess school, out-of-school and family correlates of weekday compliance with PA recommendations in weekend non-compliant youth aged 6–16 years old in Switzerland.

2. Methods

2.1. Recruitment

SOPHYA (*Swiss children's Objectively measured PHYsical Activity*) is a cross-sectional study conducted among children and adolescents living in Switzerland. It aims to identify socio-demographic and environmental correlates of objectively measured PA in a nation-wide sample of Swiss youth, to develop evidence-based PA promotion strategies (Swiss Tropical and Public Health Institute, 2016).

All youth living in Switzerland and born between 1998 and 2007 were considered for inclusion. A random sample was recruited between 2013 and 2015 by the Federal Statistical Office. 3113 youth and their parent or legal guardian accepted to be interviewed by a field research institute regarding their socio-demographic factors and sport behavior. At the end of the telephone interview, their willingness to participate in an accelerometry measurement was assessed. A total of 1611 youth accepted and were subsequently mailed a pre-programmed accelerometer with detailed instructions for use, a questionnaire about sport behavior during the measured week, and a pre-paid postage box to return the items to the investigators. At the end of the study, 1439 (89.3%) youth provided accelerometry data. Of the 172 remaining, 20 had technical problems (1.2%), and 152 (9.4%) did not wear or return the accelerometer.

2.2. Accelerometry

PA was assessed using accelerometers (*ActiGraph GT1M* or *GT3X*, Pensacola, Florida, USA) positioned on the right hip using an elastic waist belt, without filtering and in 15-s epoch mode, to capture short bursts of MVPA typically performed by children (Trost et al., 2005). As uniaxial and triaxial accelerometers were used, only the vertical axis output was considered since it is similar between the *GT1M* and *GT3X ActiGraph* models in youth (Robusto and Trost, 2012). Participants were requested to wear the device continuously for seven consecutive days, but to take it off during water activities and during sleeping time. Season of wear was defined according to the month when the measurement was performed (spring: March–May; summer: June–August; autumn: September–November; winter: December–February).

Accelerometry data were downloaded using *ActiLife* software version 6.11 (ActiGraph, Pensacola, Florida, USA). A period of > 60 min of consecutive zeros counts was defined as non-wear time. A day was considered valid if it met at least 10 or 8 h of wear time, on weekdays or weekend days, respectively. Time spent in MVPA (min/day) was estimated using the age-dependent Freedson's count cut-offs (Freedson et al., 2005) with a threshold of 4 METs and averaged separately for valid weekdays and weekend days. Finally, compliance with WHO's PA recommendations was defined as an average ≥ 60 min/day of MVPA for weekday and weekend day.

2.3. School, out-of-school and family factors

The youth and one parent or legal guardian were interviewed by phone for socio-demographic data and sport behavior before the measurement week, and completed a questionnaire on sport behavior during the measurement week (*i.e.* number of school sport lessons and transport to school). Children aged 10 years or younger had their data provided by the parent or legal guardian. Older youth self-reported the data, except home income, parent's education, and parent's PA.

The number of school sport lessons (45 min each) performed during the week of the accelerometry measurement was categorized as 0–2 (less than the Swiss Federal recommendation (Confédération suisse, 2015)) or 3–5 (equal or more than the Swiss Federal recommendation (Confédération suisse, 2015)). Daily modes of transport to and from school were collected during the accelerometry measurement and categorized as active (walking, cycling, inline skating or other active form) or inactive (public transport, school bus, car, or other non-active form). Active transport to school was considered when > 50% of transports were active.

Participation in sports club was defined as attending organized sports club activities at least once a week, irrespective of the duration.

Parent's education was categorized into university or lower level. Parents were considered as physically active if they reported performing sport activities for at least one hour per week. Home income was defined as monthly household income before social charges and expressed in Swiss francs (1 CHF = 0.998 US$ or 0.937 € as of 10 February 2017).

2.4. Exclusion criteria

Participants who had an insufficient number of valid days for the accelerometry measurement, *i.e.* < 3 weekdays or 1 weekend day, were previously excluded from the SOPHYA data set. For the present analysis a sub-sample of the data set was used. Only youth who did not comply with the WHO's PA recommendations during the weekend were considered as eligible. From that sub-sample youth were further excluded if: 1) there were issues in data processing (60-s epoch setting and/or low frequency filtering); 2) they were on holidays during the accelerometry measurement; 3) they had missing data for age, or any school, out-of-school or family factors.

2.5. Statistical analysis

Statistical analyses were conducted in 2016 using Stata version 14.0 for MS-Windows (Stata Corp, College Station, Texas, USA). Descriptive analyses were stratified by age group (children: 6–10 years; adolescents: 11–16 years), and expressed as percentage for categorical variables or as average ± standard deviation for continuous variables. Bi- and multivariable analyses were performed on the whole sample, as no interactions were found between age group and the different covariables. Between-group comparisons were performed using chi-square test and Student's *t*-test, for categorical and continuous variables, respectively. Multivariable analyses using compliance with PA recommendations on weekdays as the dependent variable were conducted using logistic regression. Independent variables included in the model were: age (continuous), gender (female/male), season (spring/summer/autumn/winter), linguistic region (French-Italian/German),

weekly school sport lessons (0–2/3–5), active transport to school (no/yes), sports club participation (no/yes), active parent (no/yes), home income (< 6000/6000–9000/ > 9000 CHF) and parental university level (no/yes). Sensitivity analyses were performed by further adjusting for age^2. A further stratification by age group (children and adolescents) was also performed. Results were expressed as odds ratio (OR) and 95% confidence interval. Statistical significance was assessed for a two-sided test with $p < 0.05$. Power to consider the observed OR as statistically significant at $p = 0.05$ and minimum detectable OR, given the available sample size, were calculated using the power function of Stata mcc.

2.6. Ethics and consent

The SOPHYA study was conducted in accordance to Swiss Federal law and the Helsinki declaration. It was approved by the Ethics Committees of the Basel-Land, the Basel-Stadt and the Vaud cantons. Parents or legal guardians of the children, as well as the adolescents aged 12 and older, gave their signed informed consent for their participation in the study.

3. Results

3.1. Selection procedure and characteristics of the sample

Of the initial 1439 youth participating in the SOPHYA study, 100 (6.9%) were previously excluded due to an insufficient number of valid days with accelerometry data. Of the remaining 1339 participants, 636 (47.5%) were compliant with PA recommendations on the weekend and thus non-eligible for the present analysis. Of the remaining 703 eligible participants, 540 (76.8%) were retained for analysis. The selection procedure is illustrated in Fig. 1 and the characteristics of the included and excluded eligible participants are summarized in Supplementary Table 1. Among eligible participants, excluded youth were older, were less frequently sports club participants and their parents were less likely to have a university level education than the included ones.

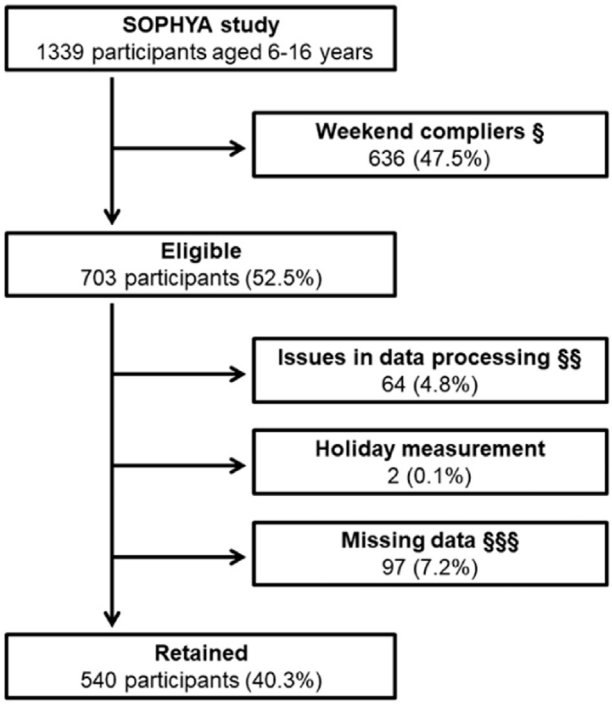

Fig. 1. Selection procedure. SOPHYA study, Switzerland, 2013–2015. §: Weekend compliers: ≥ 60 min spent in moderate-to-vigorous physical activity on weekend day in average. §§ Data processing issues: low frequency filtering instead of no filtering or 60-s instead of 15-s epoching. §§§: Missing data in age, school, out-of-school or family factors. Percentages were calculated using the baseline sample size as denominator.

Table 1
Characteristics of weekend non-compliant participants with physical activity recommendations, overall and by age group. SOPHYA study, Switzerland, 2013–2015.

	All	Children	Adolescents	*P* value
N	540	182	358	
Female (%)	58.5	62.6	56.4	0.166
Swiss linguistical region (%)				0.481
French and Italian	33.7	35.7	32.7	
German	66.3	64.3	67.3	
Week compliant (%)	52.8	80.2	38.8	< 0.001
Weekly school sport lessons (%)				0.322
0–2	37.2	40.1	35.8	
3–5	62.8	59.9	64.3	
Sports club (%)	69.1	65.4	71.0	0.186
Active transport to school (%)	69.3	79.7	64.0	< 0.001
Active parent (%)	75.2	70.3	77.7	0.063
Home income (CHF/month) §				0.687
< 6000	25.7	28.0	24.6	
6001–9000	36.7	35.7	37.2	
> 9000	37.6	36.3	38.3	
Parental university level (%)	39.8	42.9	38.3	0.303

Results are expressed as percentage. Statistical analyses by chi-square test comparing age group categories. §, 1 CHF = 0.998 US$ or 0.937 € (as of 10 February 2017).

The characteristics of weekend non-compliant participants overall and stratified by age group are summarized in Table 1. Children (6–10 years) were more frequently compliant with PA recommendations during weekdays and more frequently adopted an active transport to school than the adolescents (11–16 years).

3.2. Association of weekday compliance with school, out-of-school and family factors

The bi- and multivariable analyses of the factors associated with compliance during weekdays for weekend non-compliant participants are described in Tables 2 and 3, respectively. Power analyses are presented in Supplementary Table 2.

In the analysis of the full sample, male gender, sports club participation and transporting actively to school were associated with higher weekday compliance rates (Table 2), but only the associations for male gender and sports club participation remained significant after multivariable adjustment. Multivariable analysis also showed that, having a physically active parent was positively associated with weekday compliance (Table 3). Further adjustment for age^2 did not change the results (Supplementary Table 3). Finally, the stratification by age group led to similar associations in the adolescents (11–16 years) while only tendencies persisted for the children (6–10 years) (Supplementary Table 4).

4. Discussion

This study assessed school, out-of-school and family correlates of compliance with the WHO's PA recommendations during weekdays among weekend day non-compliant Swiss youth. Our results suggest that being a male, participating in sports club and having a physically active parent might promote compliance with PA recommendations during weekdays.

4.1. School factors

The weekly number of school sport lessons and active transport to school were not associated with weekday compliance among weekend non-compliers. These findings are in agreement with other studies that did not focus on weekend inactives (Corder et al., 2013; van Sluijs et al., 2011b), but it has been contradicted for transport to school (Lee et al.,

Table 2
Bivariable analysis of the factors associated with weekday compliance with physical activity recommendations among weekend non-compliant participants. SOPHYA study, Switzerland, 2013–2015.

Week compliant	Yes	No	*P* value
	(*N* = 255)	(*N* = 285)	
Gender			< 0.001
Female	49.5	68.6	
Male	50.3	31.4	
Linguistical region			0.142
French or Italian	30.9	36.9	
German	69.1	63.1	
Weekly school sport lessons			0.278
0–2	35.1	39.6	
3–5	64.9	60.4	
Sports club			0.024
No	26.7	35.7	
Yes	73.3	64.3	
Active transport to school			0.001
No	24.2	38.0	
Yes	75.8	62.0	
Active parent			0.082
No	21.8	28.2	
Yes	78.3	71.8	
Home income (CHF/month) §			0.340
< 6000	23.2	28.6	
6001–9000	37.5	35.7	
> 9000	39.3	35.7	
Parental university level			0.425
No	58.6	62.0	
Yes	41.4	38.0	

Results are expressed as percentage. Statistical analyses performed by chi-square test. §, 1 CHF = 0.998 US$ or 0.937 € (as of 10 February 2017).

Table 3
Multivariable analysis of the factors associated with weekday compliance with physical activity recommendations among weekend non-compliant participants. SOPHYA study, Switzerland, 2013–2015.

	OR	[95% CI]
Gender		
Female	1 (ref.)	
Male	4.30	2.71–6.81
Linguistical region		
French or Italian	1 (ref.)	
German	1.14	0.71–1.86
Weekly school sport lessons		
0–2	1 (ref.)	
3–5	1.30	0.82–2.07
Sports club		
No	1 (ref.)	
Yes	1.91	1.21–3.02
Active transport to school		
No	1 (ref.)	
Yes	0.91	0.56–1.49
Active parent		
No	1 (ref.)	
Yes	1.98	1.20–3.28
Home income (CHF/month) §		
< 6000	1 (ref.)	
6001–9000	1.55	0.90–2.67
> 9000	1.37	0.76–2.47
Parental university level		
No	1 (ref.)	
Yes	0.99	0.61–1.61

Results are expressed as odds ratio (OR) and 95% confidence interval (CI). Statistical analyses performed by logistic regression. Variables included in the model: age (continuous), season (4 categories) and listed covariables. §, 1 CHF = 0.998 US$ or 0.937 € (as of 10 February 2017).

2008; Pereira et al., 2017). Possible explanations are 1) the amounts of MVPA reached during typical school sport lessons may be insufficient, since girls and boys spend only 13% and 11%, respectively, of their school sport lessons in MVPA (Nettlefold et al., 2011); 2) the relatively small distance Swiss youth have to walk to go to school compared to other countries (Grize et al., 2010); and 3) the association might be too small to be detected with our sample size, as indicated by the low statistical power.

4.2. Out-of-school factors

Sports club participation was associated with a higher weekday compliance rate in weekend non-compliant youth. This finding is in agreement with prior studies that did not consider weekday segment (Stuart et al., 2011; Telford et al., 2016).

4.3. Family factors

Having a physically active parent was associated with a higher weekday compliance rate in weekend non-compliant youth. Two studies suggested a positive association between youth and parental weekday PA levels but they did not focus on weekend inactives (Fuemmeler et al., 2011; Sigmund et al., 2015). However, a review reported that the relationship between parental and child PA levels is still a matter of debate (Stuart et al., 2011) but these contradictory findings are limited by the use of self-reported PA. This finding might be partly explained by parental modeling (Yao and Rhodes, 2015), in which youth tend to imitate their parents' behavior, but also genetic and environmental factors (Seabra et al., 2008).

Parent's education and home income were not associated with weekday compliance among weekend non-compliers. This is in agreement with other studies for parent's education (Butcher et al., 2008; Corder et al., 2013), but not for home income that has been positively associated with PA (Stuart et al., 2011; Butcher et al., 2008). These opposite findings might be explained by the fact that they did not focus on week segments (Stuart et al., 2011; Butcher et al., 2008). Still, these findings need to be confirmed in other larger studies due to the low statistical power.

4.4. Future interventions

Future interventions should motivate weekend inactive youth to be more active. Increasing sports club participation is one solution but needs careful attention (Geidne et al., 2013), as activities need to be adapted to the different age groups. Changes in the built environment could also be considered, as they have been associated with increased PA among adolescents (Perez et al., 2017; Schipperijn et al., 2015), although this statement has been challenged (McGrath et al., 2015). Finally, increased social and family support toward a more active pattern could be favored (Perez et al., 2017).

4.5. Study strengths and limitations

As far as we know, this is the first study exploring weekday correlates of PA focusing on weekend inactive youth. Importantly, the analyses were performed using an objective measure of PA and included potential correlates from various fields. Moreover, our participants came from all over the Switzerland including rural as well as urban areas, private as well as public schools, and different cultures; therefore, our results can be generalized to all Swiss children and adolescents.

This study has several limitations worth acknowledging. Firstly, the cross-sectional design of this study precludes the assessment of any causal effects. Secondly, the sample size for weekend non-compliant youth was relatively small, leading to a limited statistical power which may have hidden some associations. Thirdly, the factors included in this

study did not cover all potential correlates of weekday compliance, such as school recesses or after-school non-structured activities. However, it was reported that recesses represent only a small amount of PA (Nettlefold et al., 2011) and that after-school time is spent mainly in sedentary behavior (Vanhelst et al., 2016).

5. Conclusion

In a Swiss sample of weekend inactive youth, being a male, participating in sports club and having a physically active parent were significantly associated with compliance to WHO's PA recommendations during weekdays. Promoting sports club participation would therefore seem to be a good strategy to combat weekday inactivity among weekend inactive youth.

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Authors' contributions

CG conducted most of the statistical analyses and wrote most of the article. PMV conducted part of the statistical analysis and wrote part of the article. BB was involved in the planning and the coordination of the study; she supervised the data collection and conducted the data cleaning. SS was involved in the planning of the study and supervised the data collection in the Italian part of Switzerland. PV revised the article for important intellectual content. BK was involved in the planning of the study and supervised the data collection in the French speaking part of Switzerland; he suggested the research question, supervised the data analyses and the writing of the article. All co-authors read and approved the final version of the manuscript.

Conflict of interest

The authors report no conflict of interest.

Transparency document

The Transparency document associated with this article can be found, in online version.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.pmedr.2017.12.004.

References

Aires, L., Santos, R., Silva, P., et al., 2007. Daily differences in patterns of physical activity among overweight/obese children engaged in a physical activity program. Am. J. Hum. Biol. 19 (6), 871–877.

Brooke, H.L., Corder, K., Atkin, A.J., van Sluijs, E.M., 2014. A systematic literature review with meta-analyses of within- and between-day differences in objectively measured physical activity in school-aged children. Sports Med. 44 (10), 1427–1438.

Bürgi, R., de Bruin, E.D., 2016. Differences in spatial physical activity patterns between weekdays and weekends in primary school children: a cross-sectional study using accelerometry and global positioning system. Sports 4 (3), 36.

Butcher, K., Sallis, J.F., Mayer, J.A., Woodruff, S., 2008. Correlates of physical activity guideline compliance for adolescents in 100 U.S. Cities. J. Adolesc. Health 42 (4), 360–368.

Confédération suisse, 2015. Ordonnance sur l'encouragement du sport et de l'activité physique: Art. 49, al. 2 (cited 2017 May 4). Retrieved from https://www.admin.ch/opc/fr/classified-compilation/20111821/index.html.

Corder, K., Craggs, C., Jones, A.P., Ekelund, U., Griffin, S.J., van Sluijs, E.M., 2013. Predictors of change differ for moderate and vigorous intensity physical activity and for weekdays and weekends: a longitudinal analysis. Int. J. Behav. Nutr. Phys. Act. 10, 69.

Fairclough, S.J., Ridgers, N.D., Welk, G., 2012. Correlates of children's moderate and vigorous physical activity during weekdays and weekends. J. Phys. Act. Health 9 (1), 129–137.

Freedson, P., Pober, D., Janz, K.F., 2005. Calibration of accelerometer output for children. Med. Sci. Sports Exerc. 37 (11 Suppl), S523–30.

Fuemmeler, B.F., Anderson, C.B., Masse, L.C., 2011. Parent-child relationship of directly measured physical activity. Int. J. Behav. Nutr. Phys. Act. 8, 17.

Geidne, S., Quennerstedt, M., Eriksson, C., 2013. The youth sports club as a health-promoting setting: an integrative review of research. Scand. J. Public Health 41 (3), 269–283.

Grize, L., Bringolf-Isler, B., Martin, E., Braun-Fahrlander, C., 2010. Trend in active transportation to school among Swiss school children and its associated factors: three cross-sectional surveys 1994, 2000 and 2005. Int. J. Behav. Nutr. Phys. Act. 7, 28.

Guinhouya, B.C., Lemdani, M., Vilhelm, C., Hubert, H., Apete, G.K., Durocher, A., 2009. How school time physical activity is the “big one” for daily activity among school-children: a semi-experimental approach. J. Phys. Act. Health 6 (4), 510–519.

Lamprecht, M., Fischer, A., Wiegand, D., Stamm, H.P., 2015. Sport Suisse 2014: Rapport sur les enfants et les adolescents. Macolin, Office fédéral du sport OFSPO.

Lee, M.C., Orenstein, M.R., Richardson, M.J., 2008. Systematic review of active commuting to school and childrens physical activity and weight. J. Phys. Act. Health 5 (6), 930–949.

McGrath, L.J., Hopkins, W.G., Hinckson, E.A., 2015. Associations of objectively measured built-environment attributes with youth moderate-vigorous physical activity: a systematic review and meta-analysis. Sports Med. 45 (6), 841–865.

McMinn, A.M., Griffin, S.J., Jones, A.P., van Sluijs, E.M., 2013. Family and home influences on children's after-school and weekend physical activity. Eur. J. Pub. Health 23 (5), 805–810.

Nettlefold, L., McKay, H.A., Warburton, D.E., McGuire, K.A., Bredin, S.S., Naylor, P.J., 2011. The challenge of low physical activity during the school day: at recess, lunch and in physical education. Br. J. Sports Med. 45 (10), 813–819.

Pereira, S., Borges, A., Gomes, T.N., et al., 2017. Correlates of children's compliance with moderate-to-vigorous physical activity recommendations: a multilevel analysis. Scand. J. Med. Sci. Sports 27 (8), 842–851.

Perez, L.G., Conway, T.L., Arredondo, E.M., et al., 2017. Where and when adolescents are physically active: neighborhood environment and psychosocial correlates and their interactions. Prev. Med. 105, 337–344.

Poitras, V.J., Gray, C.E., Borghese, M.M., et al., 2016. Systematic review of the relationships between objectively measured physical activity and health indicators in school-aged children and youth. Appl. Physiol. Nutr. Metab. 41 (6 Suppl. 3), S197–239.

Robusto, K.M., Trost, S.G., 2012. Comparison of three generations of ActiGraph activity monitors in children and adolescents. J. Sports Sci. 30 (13), 1429–1435.

Schipperijn, J., Ried-Larsen, M., Nielsen, M.S., et al., 2015. A longitudinal study of objectively measured built environment as determinant of physical activity in young adults: the European youth heart study. J. Phys. Act. Health 12 (7), 909–914.

Seabra, A.F., Mendonca, D.M., Goring, H.H., Thomis, M.A., Maia, J.A., 2008. Genetic and environmental factors in familial clustering in physical activity. Eur. J. Epidemiol. 23 (3), 205–211.

Sigmund, E., Sigmundova, D., Badura, P., Voracova, J., 2015. Relationship between Czech parent and child pedometer-assessed weekday and weekend physical activity and screen time. Cent. Eur. J. Public Health 23 (Suppl), S83–90.

Stuart, J.H., AJA, Biddle, Cavill, Nick, Foster, Charlie, 2011. Correlates of physical activity in youth: a review of quantitative systematic reviews. Int. Rev. Sport Exerc. Psychol. 4, 1,25–49.

Swiss Tropical and Public Health Institute, 2016. SOPHYA: Swiss Children's Objectively Measured Physical Activity (cited 2017 May 4). Retrieved from https://www.swisstph.ch/fr/about/eph/chronic-disease-epidemiology/physical-activity-and-health/sophya/.

Telford, R.M., Telford, R.D., Cochrane, T., Cunningham, R.B., Olive, L.S., Davey, R., 2016. The influence of sport club participation on physical activity, fitness and body fat during childhood and adolescence: the LOOK longitudinal study. J. Sci. Med. Sport 19 (5), 400–406.

Trost, S.G., McIver, K.L., Pate, R.R., 2005. Conducting accelerometer-based activity assessments in field-based research. Med. Sci. Sports Exerc. 37 (11 Suppl), S531–43.

van Sluijs, E.M., Kriemler, S., McMinn, A.M., 2011a. The effect of community and family interventions on young people's physical activity levels: a review of reviews and updated systematic review. Br. J. Sports Med. 45 (11), 914–922.

van Sluijs, E.M., Jones, N.R., Jones, A.P., Sharp, S.J., Harrison, F., Griffin, S.J., 2011b. School-level correlates of physical activity intensity in 10-year-old children. Int. J. Pediatr. Obes. 6 (2–2), e574–81.

Vander Ploeg, K.A., Kuhle, S., Maximova, K., McGavock, J., Wu, B., Veugelers, P.J., 2013. The importance of parental beliefs and support for pedometer-measured physical activity on school days and weekend days among Canadian children. BMC Public Health 13, 1132.

Vanhelst, J., Beghin, L., Duhamel, A., et al., 2016. Relationship between school rhythm and physical activity in adolescents: the HELENA study. J. Sports Sci. 1–8.

Verloigne, M., Van Lippevelde, W., Maes, L., et al., 2012. Levels of physical activity and sedentary time among 10- to 12-year-old boys and girls across 5 European countries using accelerometers: an observational study within the ENERGY-project. Int. J. Behav. Nutr. Phys. Act. 9, 34.

World Health Organization, 2010. Global Recommendations on Physical Activity for Health (cited 2017 May 4). Retrieved from: http://www.who.int/dietphysicalactivity/factsheet_recommendations/en/.

Yao, C.A., Rhodes, R.E., 2015. Parental correlates in child and adolescent physical activity: a meta-analysis. Int. J. Behav. Nutr. Phys. Act. 12, 10.