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RESEARCH

Changes in physical activity patterns from adolescence to young adulthood: the BELINDA study

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Abstract

Physical activity (PA) is recognized as a marker of health. The aim was to investigate PA differences from adolescence to young adulthood. European adolescents included in the HELENA study were invited to participate in a follow-up study, 10 years later. The present study included 141 adults (25.0 ± 1.4 years) for whom valid accelerometer data were available in adolescence and adulthood. Changes in PA by sex, weight and maternal education level were explored with interactions. Time spent in sedentary activity, light PA (LPA) and moderate PA (MPA) increased by 39.1, 59.6 and 6.6 min/day, respectively, whereas the time spent in vigorous PA (VPA) decreased by 11.3 min/day compared with adolescent VPA ($p < 0.05$). Increases in MPA were greater on weekends compared with weekdays, but we found a greater decrease in VPA on weekdays compared with weekends. Moderate-to-vigorous PA (MVPA) decreased significantly on weekdays (–9.6 min/day; 95%CI, –15.9 to –3.4), while it increased on weekends (8.4 min/day; 95%CI, 1.9 to 14.8). Significant heterogeneity was found across sexes for VPA and MVPA, with a stronger decrease in VPA in males compared with females and a significant decrease in MVPA (–12.5 min/day; 95%CI, –20.4 to –4.5) in males but not in females (1.9 min/day; 95%CI, –5.5 to 9.2). No significant heterogeneity was found to be linked to maternal education level or weight, irrespective of PA level.

Conclusion: Our data suggest that the transition from adolescence to young adulthood is a critical period for lifestyle PA habits. A decline in VPA and an increasingly sedentary time were observed. The observed changes are worrying and may increase the risk of developing adverse health consequences later in life.

What is Known:
- *The transition from adolescence to adulthood is marked by many life changes affecting lifestyle habits. Most studies tracking physical activity from adolescence to adulthood were done using PA questionnaires, which is a subjective method.*

What is New:
- *Our study bring first data on objective changes in PA patterns between adolescence and young adulthood, taking account of BMI, sex and maternal educational level. Our results suggest that the transition from adolescence to young adulthood is a critical period for lifestyle PA habits, especially for time spent on sedentary activities.*

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Keywords Physical activity · Tracking · Health

Introduction

The transition from adolescence to adulthood induces major life changes including residential independence; other changes in living arrangements, academic and employment status; and new social roles [1, 2]. This transition is associated with modification of lifestyle habits including physical activity (PA) and sedentary behaviours, which are two important contributors to maintaining good health throughout life [3]. It has been shown that increasing participation in moderate-to-vigorous PA (MVPA) (e.g. brisk walking, nice hiking, dancing, gardening, bicycling or jogging) has important health benefits, such as decreasing risk factors for obesity, cardiovascular and pulmonary diseases, cancer and depression and improving bone health [4]. Despite the health benefits of PA, most studies have shown that PA and MVPA decline during the transition from adolescence to adulthood, replaced by increased time spent on sedentary activities [5, 6]. In this context, and given the positive impact of PA on health, it is of interest to understand the determinants of PA patterns during adolescence that affect later life.

In a systematic review and meta-analysis, based on 49 studies, the transition from adolescence to adulthood was associated with a decline by a mean of 5.2 min/day for MVPA (or approximately 13% of the baseline value) [7]. In addition, the decline in PA was slightly larger in males than females (− 6.5 vs − 5.5 min/day). However, most studies (91%) tracking PA from adolescence to adulthood were done using PA questionnaires [7]. The major problem with the use of PA questionnaires is that they are self-reported and subjective, which makes them susceptible to errors such as social desirability, lack of awareness or perceptual bias. This can lead to over- or under-reporting, particularly in youth [8]. Indeed, when using only accelerometer data, the decline found in the meta-analysis was larger with each year of follow-up (further decline of − 1.3 min/day per year) [7]. In this context, a device-based method, such as accelerometry, is needed to track PA from adolescence to adulthood. Most studies ($n = 6/9$) that used an accelerometer were based on a short tracking period averaging 4 years just at the end of adolescence (range of 15 to 19 years old) and not during adulthood [7].

Several factors associated with the changes in PA and/or sedentary time from adolescence to young adulthood have been reported [7]. First, the change magnitude was larger in males compared to females [7]. Maternal education level, used also as an indicator of socioeconomic status, showed contradictory results with PA changes in adolescence and adulthood [9, 10]. Mitchell et al. observed a larger increase in sedentary time in participants having a mother with a higher level of education during adolescence, while Ortega et al. showed no impact of maternal educational level from adolescence to adulthood [9, 10]. Similarly, no difference in PA trajectories was found in body mass index (BMI) or type of day (week or weekend) during the transition from adolescence to adulthood [9]. Future studies are needed to confirm these findings.

Therefore, the main aim of the present study was to track PA, using device-assessed PA, from adolescence to adulthood in a European population-based study. A secondary aim was to study the influence of sex, weight in adolescence, parts of the week when PA occurred (weekdays vs. weekends) and maternal education levels.

Methods

Study population

This study was part of a follow-up of the Healthy Lifestyle in Europe by Nutrition in Adolescence (HELENA) cross-sectional study. The HELENA study was a multicentre study, randomized and stratified by geographical location, age and socioeconomic status. A total of 3528 adolescents aged 12.5–17.5 years were enrolled between 2006 and 2007 from 10 European cities: Athens and Heraklion (Greece), Dortmund (Germany), Ghent (Belgium), Lille (France), Pecs (Hungary), Rome (Italy), Stockholm (Sweden), Vienna (Austria) and Zaragoza (Spain). Details on specific sampling methods have been reported elsewhere [11].

Our follow-up study, called the Better Life by Nutrition During Adulthood (BELINDA) study (ClinicalTrials.gov NCT02899416), began in 2017, 10 years after the HELENA study. The main aim of the BELINDA study was to assess cardiovascular risk during young adulthood and to analyse lifestyle risk factors stemming from adolescence. Among the 10 centres and the 3 528 subjects included in the HELENA study, four centres agreed to participate in the recruitment for the BELINDA study: Ghent (Belgium), Lille (France), Rome (Italy) and Zaragoza (Spain). A total of 1327 subjects were eligible. Among these 1327 subjects, 1095 were unreachable, untraceable, refused or were unable to participate because of the COVID-19 pandemic [12]. The final database contains a total of 232 subjects (participation rate = 18%), assessed in the HELENA study and reassessed 10–14 years later in the BELINDA study, versus 1095 adolescents who did not participate in BELINDA (Fig. 1). From the total population of 232 young adults in the source BELINDA study, a subgroup of 141 participants (61%) was included in the present analysis, as complete PA data were available for these participants (Fig. 1). Indeed, of the 232 participants who wore an accelerometer throughout the 7

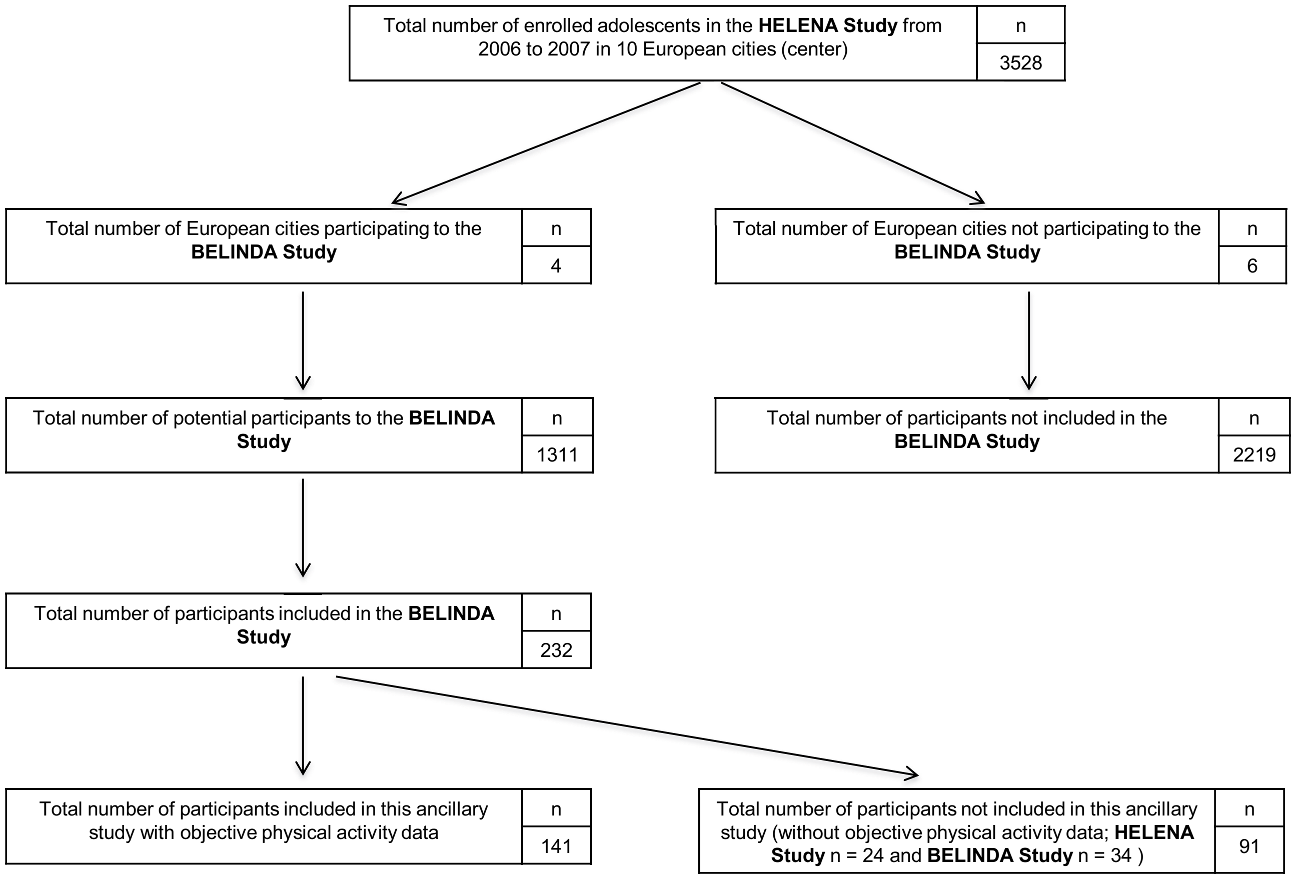

Fig. 1 Flow chart of the study

consecutive days, 91 were excluded because of device malfunction or less than 3 days recording.

The aims and objectives of the present study were explained to each participant and informed, written consent was obtained from each. The study was approved by the ethics committee of each country, and all procedures were performed in accordance with the ethical standards of the Helsinki Declaration of 1975 as revised in 2008.

Anthropometry

Body weight was measured to the nearest 0.1 kg using an electronic scale (SECA 871; SECA, Hamburg, Germany) with the participant wearing shorts and a T-shirt without shoes. Height was measured without shoes to the nearest 0.1 cm using a stadiometer (SECA 225; SECA). BMI was calculated as weight per height squared (kg/m^2).

PA measurement

A uniaxial accelerometer (ActiGraph®, Model GT1M, Pensacola, FL, USA) was used in the HELENA study, while a triaxial accelerometer was used (ActiGraph®, Model GT3X; ActiGraph, Pensacola, CA, USA) in the BELINDA study. No significant difference between GT1M and GT3X results was shown when data were collected in the uniaxial mode [13]. Uniaxial mode (vertical axis) data were recorded in this present study, allowing valid comparison with the adolescent data from the HELENA study.

Participants wore the accelerometer on the lower back, fastened with an elastic belt and adjustable buckle. The epoch interval was set at 15 s. They were then asked to follow their normal daily routine and instructed to remove the accelerometer during swimming, showering and bathing and in bed at night. The accelerometer recorded PA for 7 consecutive days.

Data were downloaded from the accelerometer to a computer after the 7 days. Participants who did not record at least 3 days of PA with a minimum of 10 h of PA per day were excluded from the analyses [14, 15]. For adolescent data (HELENA), zero PA periods of 20 min or longer were interpreted as "not worn time"; these periods were deleted from the summation of PA. For the young adult data (BELINDA), the Troiano algorithm was used to interpret "not worn time", corresponding to a minimum of 60 min of no PA (counts/min values) with an allowance of 2 min of interruptions [16].

For the HELENA study, the assessment of time spent in sedentary activities, light PA (LPA), moderate PA (MPA) and vigorous PA (VPA) was based on the cut-off points of 0–400, 401–1900, 1901–3918 and > 3918 counts/min, respectively [17]. For the BELINDA study, the assessment of time spent in sedentary activities, LPA, MPA and VPA was based on the cut-off points of 0–99, 100–1951, 1952–5724 and > 5724 counts/min, respectively [18].

Demographic and lifestyle measurements at baseline

Based on physical examination and questionnaires, anthropometric characteristics were collected at adolescence: sex, age and maternal education level. Maternal education level was classed in two categories (lower education and higher secondary education/university education).

Statistical analysis

Quantitative variables are expressed as mean (standard deviation (SD)), and categorical variables are expressed as numbers (percentage). Participants' characteristics were compared between included and non-included using the chi-square test for categorical variables and the Student *t* test or Mann–Whitney *U* test for quantitative variables according to normality. Among the eligible participants originally enrolled in the HELENA study (from four participating centres), imbalances in baseline HELENA-determined characteristics (including PA measurement) between included and excluded former adolescents were assessed by performing a chi-square test for categorical variables and Student *t* test or Mann–Whitney *U* test for quantitative variables according to normality and by calculating absolute standardized differences. An absolute standardized difference of > 20% was interpreted as a meaningful difference [19].

We estimated the mean change in PA measurements (sedentary activity, LPA, MPA and VPA) from the baseline to the 10-year follow-up by using a linear mixed model including time (baseline vs. 10-year follow-up) as a fixed effect and participants and centres as random effects to account for the correlation between baseline and 10-year measures for each participant (participant effect) and the correlation between participant measures within a centre (centre effect). Normality of linear mixed model residuals was graphically examined using histograms and quantile–quantile plots, and none major deviation was detected. We further assessed the heterogeneity of PA changes across subgroups (sex, weight at baseline, maternal educational level and the weekly phase of PA measurement (weekday vs. weekend)) by using mixed linear models; participants and centres were random effects, and time, subgroup and their interactions were fixed effects. Mean changes in PA measurements in each subgroup were estimated using the time and time × subgroup interaction terms using linear contrasts.

Statistical testing was done at the two-tailed α level of 0.05. No correction for multiple testing was applied. Data were analysed using the SAS software package, release 9.4 (SAS Institute, Cary, NC, USA).

Results

From the 1311 HELENA adolescents previously enrolled in the four participating centres, 232 participants were subsequently enrolled in the BELINDA study. From these participants, 141 (76 females, 65 males) with complete data on PA at both baseline (adolescence) and 10-year follow-up (young adult) were included in the present study (Table S1). Except for age, no difference was found between the included and excluded adolescents from the sample of 232 participants (Table S1). The main characteristics at baseline (i.e. assessed in PA measures of the HELENA study) of included and excluded adolescent participants are presented in Table 1. Compared with excluded adolescent participants, included participants had a lower BMI level (less frequently classified as overweight, 11.3% vs. 21.4%) and more often had a mother with higher educational level (51.5% vs. 38.8%). However, no meaningful difference in PA measurements at adolescence age was observed (all absolute standardized differences were < 20%). Baseline and 10-year follow-up characteristics of the 141 included participants are presented in Table 2. The number of participants included in the weekday and weekend samples is presented in supplemental table (Table S2).

Table 3 shows the 10-year mean changes in PA level patterns of the 141 participants. By comparison with baseline values, the mean time spent in sedentary activity, LPA and MPA levels 10 years later increased by 39.1, 59.6 and 6.6 min.day^{-1}, respectively, whereas the time spent in VPA and MVPA decreased by 11.3 and 4.7 min.day^{-1}, respectively; except for the MVPA change, all changes were statistically significant. Regarding the rate of participants with any decrease in PA measurements between baseline and 10 years, 53.2% (95%CI, 44.9 to 61.4%) and 90.0% (95%CI, 85.0 to 95.0%) of participants decreased their time spent in MVPA and VPA, respectively.

Figure 2 displays the 10-year mean changes in PA levels according to subgroups defined according to key baseline characteristics (nutritional status, sex, maternal education level, weekly phase of PA). We found significant heterogeneity in mean changes in MPA, VPA and MVPA according to weekly phase; we found greater mean increases in

Table 1 Comparison of main baseline characteristics between the included and non-included participants enrolled in the four participating centres of HELENA study

Baseline (adolescent) characteristics	**Included ($n = 141$)**	**Non-included ($n = 1170$)**	***P* value**	**ASD, %**
Age (*years*)	14.6 ± 1.2	14.8 ± 1.2	0.16	12.9
Males	65/141 (46.1)	525/1170 (44.9)	0.78	2.5
Weight (*kg*)	56 ± 11	58 ± 12	0.027	18.8
Height (*cm*)	166 ± 9	165 ± 9		11.8
Body mass index (kg/m^2)	20.1 ± 2.8	21.1 ± 3.6	< 0.001	32.3
Underweight	13/133 (9.8)	86/1170 (7.3)	0.033	30.8
Normal weight	105/133 (78.9)	834/1170 (71.3)		
Overweight & obese	15/133 (11.3)	250/1170 (21.4)		
High mother education level	70/136 (51.5)	433/1117 (38.8)	0.004	25.8
PA ($min.day^{-1}$)				
Sedentary	548 ± 159	536 ± 161	0.41	7.6
LPA	114 ± 40	108 ± 38	0.074	15.8
MPA	36 ± 17	36 ± 16	0.55	5.4
VPA	14 ± 12	14 ± 13	0.68	3.9
MVPA	51 ± 26	49 ± 26	0.55	5.4
Counts.min^{-1}	473 ± 243	459 ± 243	0.52	5.8

Values are means ± SD or no./total.no (%)

ASD absolute standardized difference, *PA* physical activity, *LPA* light physical activity, *MPA* moderate physical activity, *VPA* vigorous physical activity, *MVPA* moderate-to-vigorous physical activity

MPA for weekend PA compared with weekday PA. In contrast, we found a greater mean decrease in VPA on weekdays compared with weekends. For MVPA, a significant mean decrease for weekdays was observed (–9.6 min/day; 95%CI, –15.9 to –3.4) whereas a significant mean increase for weekend days was observed (8.4 min/day; 95%CI, 1.9 to 14.8). An additional analysis focusing on weekend days by separating Saturday and Sunday days is presented in the supplemental table (Table S3).

We also found significant heterogeneity across sexes in VPA and MVPA, with a stronger decrease in VPA for males compared with females, and a significant decrease in MVPA (–12.5 min/day; 95%CI, –20.4 to –4.5) for males but not in females (1.9 min/day; 95%CI, –5.5 to 9.2).

Table 2 Main characteristics of the study sample at adolescence and adulthood ($N = 141$)

	Adolescents	**Young adults**
Age, years	14.6 ± 1.2	25.0 ± 1.4
Males	65/141 (46.1)	65/141 (46.1)
Weight, kg	56 ± 11	71 ± 15
Height, cm	166 ± 9	173 ± 9
Body mass index, kg/m^2	20.1 ± 2.8	23.6 ± 4.6
Underweight	13/133 (9.8)	7/141 (5.0)
Normal weight	105/133 (78.9)	99/141 (70.2)
Overweight & obese	15/133 (11.3)	35/141 (34.8)

Values are mean ± SD or no./total.no (%)

Discussion

Physical inactivity and sedentary behaviours are two major public health problems that contribute to the development of obesity and several chronic diseases, including cardiovascular and pulmonary diseases, some cancers and hypertension in adults [20, 21]. The transition from adolescence to adulthood is marked by many life changes affecting lifestyle habits. Therefore, our study aimed to examine changes in PA patterns between adolescence and young adulthood, taking account of BMI, sex and maternal educational level.

The main societal concern from our study is the important and significant increase in time spent on sedentary activities from adolescence to young adulthood. The increase of 39.1 min/day of sedentary time that we observed could have adverse health consequences [20]. In the CARDIA study, Gibbs et al. showed that, in adults, each additional hour of sedentary time accumulated in bouts of more than 10 min was associated with greater gain in adiposity (BMI and waist circumference) [22]. The change in sedentary time during a lifespan was also highlighted as potentially negative for health and with an increased risk of early mortality [23]. Our results suggest a large impact of these changes at a population level, since almost 50% of our participants significantly increased their sedentary time during the transition from adolescence to young adulthood. The reasons for such an increase are probably socio-ecologic [24]. Indeed, the transition from adolescence to adulthood includes major life changes in living arrangements, academic and employment status and marital status, which are potentially responsible

Table 3 Ten-year mean change in physical activity measurements for overall study participants

PA measurement (*min.day*$^{-1}$)	Baseline	10-year follow-up	Mean change (95%CI)[a]	Percentage of change	P value	Percentage of subjects with change[b] (95%CI)
Sedentary	548 ± 159	587 ± 106	39.1 (10.4 to 67.7)	7.0	0.008	45.4 (37.1 to 53.6)
LPA	114 ± 40	174 ± 56	59.6 (49.0 to 70.3)	53.0	< 0.001	17.0 (10.8 to 23.3)
MPA	36 ± 17	43 ± 24	6.6 (2.2 to 11.0)	19.5	0.003	39.7 (31.6 to 47.8)
VPA	14 ± 12	3 ± 5	−11.3 (−13.4 to−9.1)	78.5	< 0.001	90.0 (85.0 to 95.0)
MVPA	51 ± 26	46 ± 26	−4.7 (−10.2 to 0.8)	10.0	0.092	53.2 (44.9 to 61.4)
Counts.min^{-1}	473 ± 243	357 ± 157	−118.6 (−170.8 to−66.3)	24.5	< 0.001	75.9 (68.0 to 82.7)

Values are mean ± standard deviation unless otherwise indicated

CI confidence interval, *LPA* light physical activity, *MPA* moderate physical activity, *MVPA* moderate-to-vigorous physical activity, *VPA* vigorous physical activity

[a]Estimated using linear mixed model on average values of 7 consecutive days by including subject and centre as random effect

[b]Percentage of subjects who experienced any decrease in PA values between their first (baseline; adolescents) and last measurements (10-year follow-up, young adults)

for increasing sedentary behaviours and acting as barriers to practising PA [1, 2].

Another important finding of our study is a worrying downtrend of time spent in VPA. Ninety percent of participants reduced their daily time in VPA. On average, they dropped from 14 min to only 3 min VPA per day. Previous studies of adolescents and adults have shown the importance of VPA for health benefits, independent of MVPA [25–27]. Janssen and Ross showed that 75 min/week of VPA appeared to have greater cardiometabolic benefits than 150 min/week of MPA [26]. In a national cohort study of 400,000 US adults, a higher proportion of VPA to total PA (MVPA total), for the same volume of MVPA, was associated with lower all-cause mortality [25]. Therefore, VPA has a role in health promotion and a key message should be given by healthcare professionals that adults should practise at least some VPA over the course of a week to attain optimal health. Several targets to increase VPA throughout life may be acknowledged. First, during adolescence, sport club participation may provide an opportunity and a viable way for children and adolescents to increase VPA. Many studies showed that youth who consistently engaged in sports were more active than their non-participating peers [28–30]. Therefore, policy and governmental actions have to be engaged or continued in increasing opportunities for access to sports clubs/associations for children to be more active. These recommendations are supported by previous studies showing sports participation in adolescence has been associated with increased PA in adulthood [31, 32]. Then, promoting active commuting from home to school may be another opportunity for adolescents to be more physically active. In a systematic review, the authors showed that children and adolescents who actively commute to school accumulated significantly more PA compared to their passive commute counterparts [33]. Therefore, policies and interventions encouraging active commuting to/from school may result in increased, habitual active commuting and PA behaviour throughout childhood and possibly to maintain into adulthood. It has been demonstrated that a 6-month school-based intervention focused on increasing active commuting to school was associated with an increase in rates of cycling to school among boys and avoided increases in rates of passive commuting [34]. Lastly, the school environment can provide a significant source of PA for youth. Indeed, children and adolescents spend a substantial proportion of their time at school, and intervening in the school environment may provide opportunities for children and adolescents to be more physically active. A study comparing two school rhythms (long and short time spent inside the school) showed that adolescents having a long school rhythm was associated with higher PA levels, mainly during school recess, less time spent in sedentary activities and were more likely to meet the PA recommendations compared to adolescents with a short school rhythm [35]. In addition, a systematic review and meta-analysis showed that school recess interventions were promising for increasing MVPA [36]. Promoting PA during recess throughout the school course could help off-set the age-related decline in physical activity. Educational policies should support the development of modifications of school environment such as playground markings demarcation of physical activities zones and availability of sports equipment to help youth to increase physical activity in school recess and daily amounts PA. In adults, several determinants can also influence PA behaviour, i.e. sport participation and being currently employed [1, 37]. A strong association between high PA levels and frequent participation in sport and membership in a sports club during adulthood was demonstrated [37]. An increase in sedentary professions may explain the decrease in PA in adults. Strategies by employers for the promotion of PA and health in adults may have a positive impact on PA levels and other health outcomes [38].

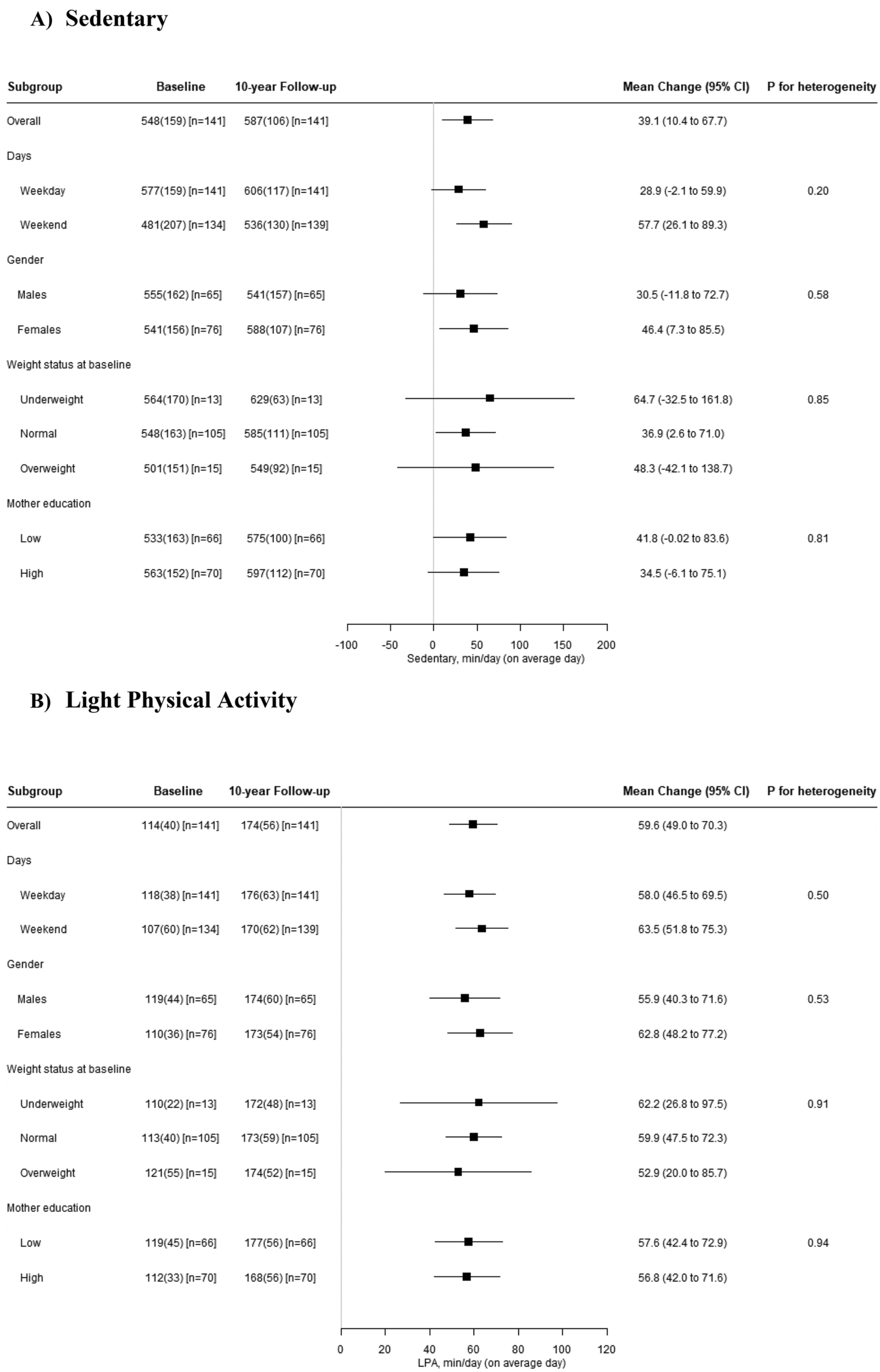

Fig. 2 Ten-year mean change in physical activity measurements according to key subgroups. Mean change (95%CI) was estimated in each subgroup by using linear mixed model on PA values by including subject and centrw as random effect, time, subgroup and interaction time × subgroup as fixed effects

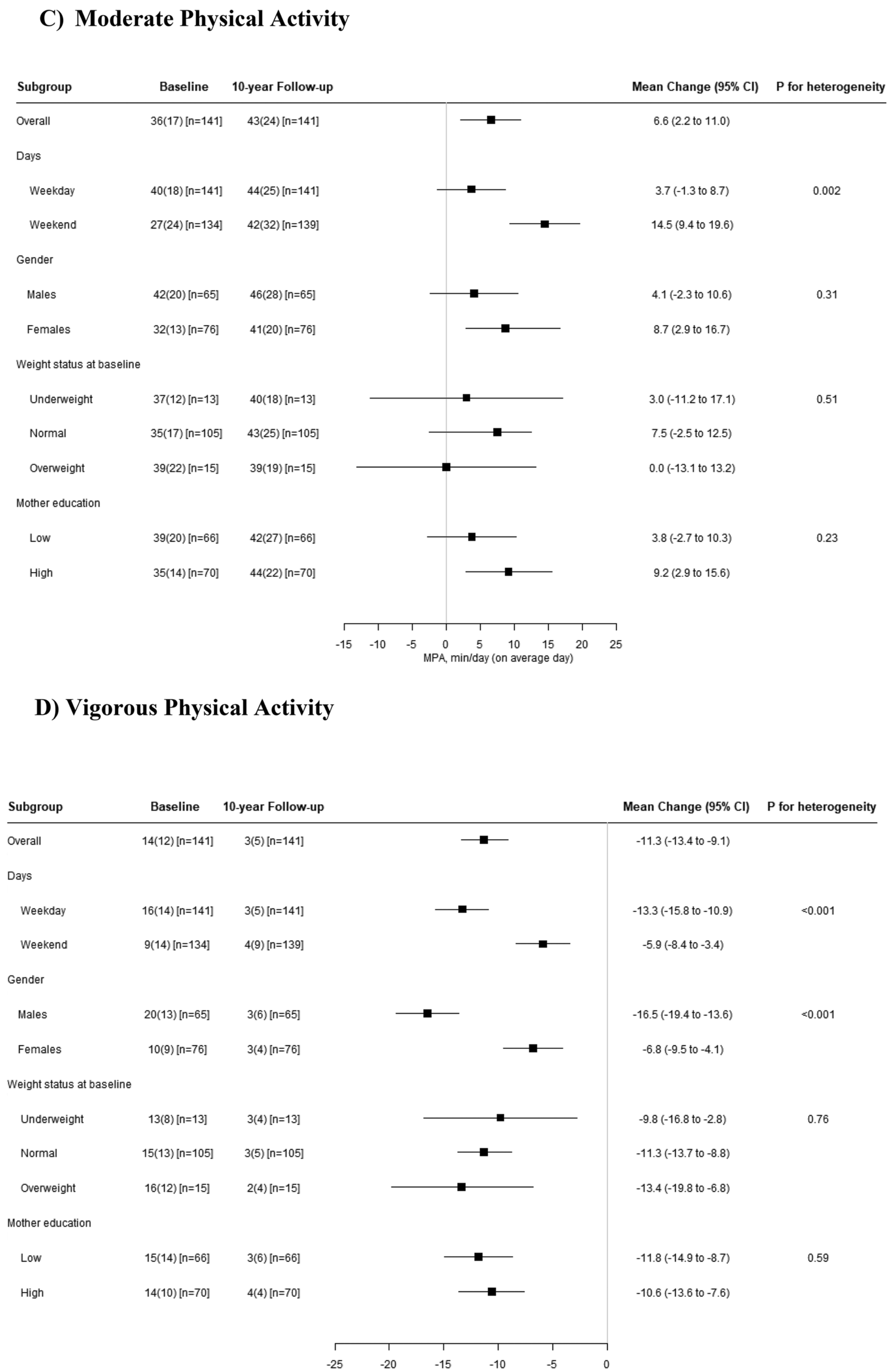

Fig. 2 (continued)

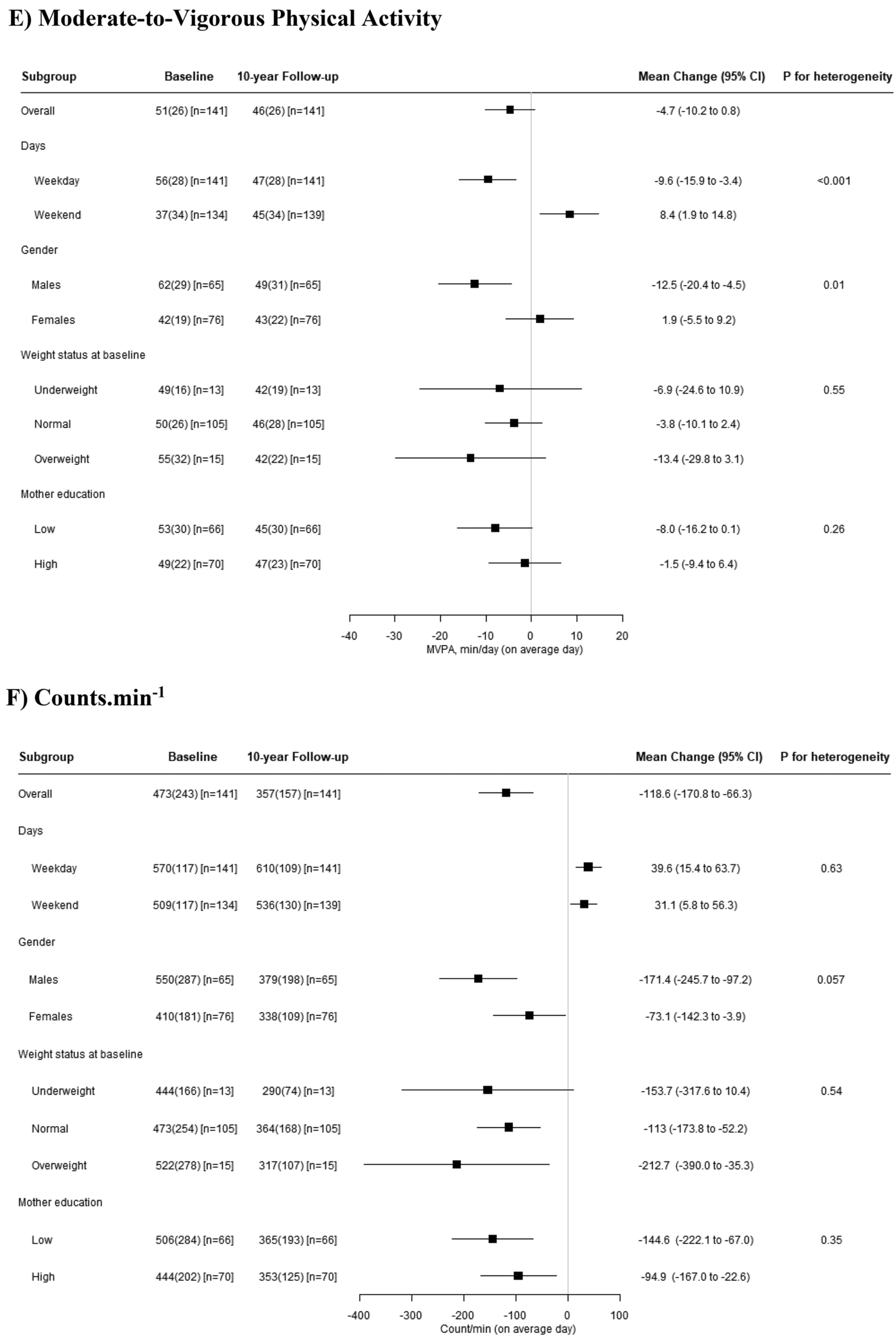

Fig. 2 (continued)

Our study also showed a greater decline of MVPA and VPA in males than females, consistent with previous studies [9, 39]. This might be related to lower PA levels in girls in adolescence [40, 41]. Since girls are already less active in adolescence, their PA will decrease less during the adolescent-to-young adult transition compared with boys, who have higher levels of PA during adolescence. Another explanation was proposed by Ortega et al.: boys were more likely to become more overweight than girls over a 6-year follow-up period, and therefore, excess weight would have greater negative impact on their willingness to undertake PA [9].

Results from this study should be taken with caution due to some methodological issues in PA assessment. Although accelerometer cut points used were validated and widely used in adolescents and adult's population, an activity intensity misclassification risk may be acknowledged in our tracking study. Indeed, cut points represent absolute intensity thresholds which means they do not account for differences in relative intensity between individuals. In our study, we decided to use different cut points for adolescents and young adults, but we cannot exclude that the PA level assessment of adolescents aged 14–15 differed from young adults aged 24–26 years. In order to overcome these limitations, we decided also to explore the PA levels tracking using a standardized metric based on counts data provided from the vertical axis, expressed in count per minute (counts.min^{-1}). These additional analyses confirmed our previous results with a decrease of PA (24.5%) from adolescence to young adulthood.

Our findings have several important public health implications. Promotion and prevention strategies should focus on males in young adulthood for maintaining the high level of PA acquired during adolescence and for females in early adolescence to increase the time spent on MVPA. Interventions should focus on both males and females as regards increasing time spent on MVPA, especially VPA, and reducing sedentary time.

The current study has important strengths compared with previous studies: its longitudinal design, harmonization and standardization of assessment for all participating countries and a robust methodology using device-assessed PA. However, our study has a sample size limitation. Attrition and compliance may have biassed our findings. We cannot exclude that changes in MVPA and sedentary behaviour might be different or similar in missing participants. Then, as previously described, our study has only two follow-up points, while several points would be desirable to assess the tracking lifestyle habits. In addition, as mentioned above, the thresholds used to classify PA may have affected the results [42]. Variations in weather conditions during PA assessment were not recorded but may also have affected our results [43]. In addition, although the present data derive from 4 countries, it is not possible to assume that the studied cohort is fully representative of the population of European adults. From 232 participants, only 141 (61%) were included in this present ancillary study which may cause to a selection bias. Finally, since no formal sample size or a priori power calculation was done, we caution that we could not excluded a lack of adequate statistical power to detect significant changes especially in subgroup analysis with small number of subjects in some strata such as weight status. For all these reasons, the present findings should be interpreted with caution and needed to be replicated in further larger studies.

In summary, our results suggest that the transition from adolescence to young adulthood is a critical period for lifestyle PA habits, especially for time spent on sedentary activities. Our findings suggest an urgent need to focus on the promotion of healthy PA habits during adolescence to develop favourable health benefits in later life.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s00431-023-04948-8.

Authors' contributions Jérémy Vanhelst and Laurent Béghin conducted the initial analyses and drafted the initial manuscript. Elodie Drumez and Julien Labreuche conducted statistical analysis and drafted the initial manuscript. Frédéric Gottrand, Luis Moreno, Stefaan De Henauw, Nathalie Michels, Angela Polito, Thaïs de Ruyter, Laura Censi, Marika Ferrari and Maria Luisa Miguel-Berges designed data collection instruments, coordinated and supervised data collection and reviewed the manuscript. All authors approved the final manuscript as submitted and agree to be accountable for all aspects of the work.

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Data availability Data are available upon reasonable request.

Declarations

Competing interests The authors declare no competing interests.

Ethics approval The study was approved by the ethics committee of each country, and all procedures were performed in accordance with the ethical standards of the Helsinki Declaration of 1975 as revised in 2008.

Consent to participate The aims and objectives of the present study were explained to each participant, and informed, written consent was obtained from each.

Consent for publication NA.

Conflict of interest The authors declare no competing interests.

Disclaimer The authors alone are responsible for the views expressed in this article, and they do not necessarily represent the views, decisions or policies of the institutions with which they are affiliated.

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