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Original/*Deporte y ejercicio*

Correlates of objectively measured physical activity in adolescents with Down syndrome: the UP & DOWN Study

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Abstract

Introduction: **correlates of physical activity (PA) have not been explored in adolescents with Down syndrome (DS). Understanding correlates of PA could provide information to develop strategies to increase levels of PA in this target population.**

Objective: **the aim of this study was to identify potential correlates of PA in adolescents with DS.**

Method: **information about levels of PA and their potential correlates was collected in 98 adolescents with DS (63 males, aged 11-20 years) using accelerometers and proxy-reported questionnaires. Analysis of covariance and multiple linear regression analyses were conducted to examine correlates of PA.**

Result: **our findings showed that participant's age and socioeconomic status were associated with levels of PA as non-modifiable correlates. Also, parental support, father PA, television-viewing time with siblings and with friends were associated with levels of PA as modifiable correlates.**

Discussion and conclusion: **both modifiable and non-modifiable factors are associated with levels of PA in adolescents with DS. Therefore, a better understanding of correlates of PA could contribute to develop strategies on PA promotion in adolescents with DS.**

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Key words: *Adolescent. Down syndrome. Correlates. Physical activity.*

CORRELATOS DE ACTIVIDAD FÍSICA MEDIDOS OBJETIVAMENTE EN ADOLESCENTES CON SÍNDROME DE DOWN: ESTUDIO UP & DOWN

Resumen

Introducción: **los correlatos de actividad física (AF) no han sido estudiados en adolescentes con síndrome de Down (SD). Entendiendo los correlatos de AF se podría aportar información para desarrollar estrategias para incrementar los niveles de AF en esta población diana.**

Objetivo: **el objetivo de este estudio fue identificar correlatos de AF en adolescentes con SD.**

Métodos: **la información de los niveles de AF y sus potenciales correlatos fue recogida en 98 adolescentes con SD (63 hombres, con edades comprendidas entre 11-20 años), usando acelerómetros y cuestionarios proxy-reportados. Se utilizó análisis de covarianza y análisis de regresión lineal múltiple para examinar los correlatos de AF.**

Resultados: **nuestros resultados muestran que la edad y el estatus socioeconómico de los participantes fue asociado con niveles de AF como correlatos no modificables. Además, el apoyo de los padres, la AF del padre y el tiempo dedicado a ver la televisión con hermanos y amigos fueron asociados con niveles de AF como correlatos modificables.**

Discusión y conclusión: **ambos factores modificables y no modificables se asocian con niveles de AF en adolescentes con SD. Por lo tanto, una mejor comprensión de los correlatos de AF podría contribuir a desarrollar estrategias de promoción de la AF en adolescentes con SD.**

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Palabras clave: *Adolescentes. Síndrome de Down. Correlatos. Actividad física.*

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Abreviations

PA: Physical activity.
DS: Down syndrome.
SES: Socioeconomic status.
ICC: Intra-class correlation.
AVENA: Alimentación y Valoración del Estado Nutricional de los adolescentes.
TV: Television.
ALPHA: European research project Assessing LEVEL of Physical Activity.

Introduction

Physical activity (PA) is a lifestyle factor with an important influence on health across the lifespan[1]. According to international PA guidelines recommendations, children and adolescents should engage in at least 60 minutes of moderate-to-vigorous PA every day in order to maintain a healthy lifestyle[1]. However, recent studies indicated that adolescents with intellectual disabilities are often inactive compared with those adolescents without disabilities[2].

Down syndrome (DS) is a genetic condition with numerous clinical characteristics (i.e. increased risk in congenital heart disease, muscle hypotonicity, hypermobility of the joints or ligaments laxity)[3], which may limit their daily activity including PA[4]. In fact, objectively measured PA in adolescents with DS is often lower than recommendations[5,6,7]. Therefore, identifying potential factors that could influence levels of PA is a relevant research issues in order to develop specific interventions in this target population.

Currently, researches addressing factors that influence PA distinguishes between correlates and determinants. Correlates research demonstrates a statistical association between factors and PA while determinants research demonstrates strong causal-relationship[8]. Evidences indicate that PA should be understood within an ecological framework since PA can be influenced by multidimensional factors (demographic, behavioural, psychological, environmental and social)[9,10]. As such, it is relevant consider multiple levels of influence on PA in adolescents with DS.

To date, several studies have focused in correlates of objectively measured PA in adolescents without disabilities[8], whereas few studies focused on understanding correlates of PA in adolescence with DS[11]. Majority of studies used qualitative approaches and identified barriers to PA such as the functional independence profiles of youth with DS, lack of accessible and appropriate programs of this population, lack of friends and parents education[4,12,13]. However, to our knowledge, there are no studies exploring correlates of objectively measured PA in this population.

Therefore, the aim of the current study was to identify correlates of objectively measured PA in a relatively and heterogeneous sample of adolescents with DS.

Methods

Study design and sample

For the present study, baseline data from the UP&DOWN study (Follow UP school children AND in adolescents with DOWN syndrome: psycho-environmental and genetic determinants of PA and its impact on fitness, cardiovascular diseases, inflammatory biomarkers and mental health) were used[13]. For the purposes of this cross-sectional study, we had baseline data of a total of 98 adolescents with DS (63 males and 35 females) aged 11-20 years.

Before starting the study, all parents or legal guardians gave their written informed consent. DS participants in the UP&DOWN study met two specific inclusion criteria for participating: having an intelligence quotient over 35 and not having physical disabilities for doing PA. The relevant institutions provided us with this information according to internal clinical mandatory reports before starting the meetings with parents. The study protocols were approved by the Ethics Committee of the Hospital Puerta de Hierro (Madrid, Spain) and the Bioethics Committee of the National Research Council (Madrid, Spain).

Data collection

This study was conducted from October 2011 to December 2012 in special education schools, associations and foundations of people with intellectual disabilities from the regions of Madrid and Toledo (Spain). At each institution, accelerometers and questionnaires were distributed to the participants and collected by researchers. Adolescents wore the accelerometer attached on their lower back, fitted with an elastic belt and were instructed to take it off during aquatic activities and sleep time. Oral and written instructions and demonstrations on how to use the accelerometer were given to adolescents and parents or guardians.

Questionnaire information was obtained by parent-report due to cognitive limitations of adolescents with DS. The questionnaires analysed in the current study were part of an adapted version of the principal questionnaire of the UP&DOWN study for adolescents without disabilities, which were based on previous studies[14]. In addition, some part of this questionnaire where specifically developed to obtain information that could be especially relevant in adolescents with DS. Prior to data collection, questionnaires were piloted in 22 families with adolescents with intellectual disability and DS to assess the rea-

ding and response level was appropriate for parents' proxy-responses, as well as test-retest reliability. Specific information is provided below.

Measurements

Physical activity. Objective assessments of PA were obtained using the ActiGraph accelerometer models GT1M, GT3X and GT3X+ (Actigraph, LLC, Pensacola, FL). Previous studies have demonstrated that there is strong agreement between measures from GT1M, GT3X and GT3X+ activity monitors without needing additional calibration[15,16]. These accelerometers are valid and reliable tools to measure PA in children and adolescents[17,18]. Adolescents with DS wore the ActiGraph for at least 8 hours per day during 7 consecutive days, except during water-based activities (i.e., swimming activities). To be included in the analysis, at least 3 days of data with a minimum of 8 hours of registration per day were necessary[19]. Non-wear time was considered as sequences of 60 min of zero and these periods were removed from the analysis. Freedson´s age-specific cut-point[17] for total PA, moderate PA, and vigorous PA was used to estimates time spent in levels of PA. Moderate-to-vigorous PA was calculated by summing the time spent in moderate PA and vigorous PA (min/day). To calculate PA guidelines recommendations, moderate-to-vigorous PA was recoded as dichotomous variable between compliers and non-compliers (< 60 min/day and ≥ 60 min/day). Further information on procedures was presented elsewhere[5].

Demographics and health factors. Demographic factors included participant's gender, participant's age, parents' age and socio-economic status (SES) assessed by the Family Affluence Scale[20]. Positive health was assessed by the first item of the KIDSCREEN-10, scored on a 5-point Likert scale[21]. Additionally, height and weight of participants and parents were assessed and body mass index was calculated by standard formula (kg/m^2). In participants, weight was recorded to the nearest 0.1 kg using an electronic scale (model SECA 701) with participants dressed in lightweight clothing and without shoes and height was measured to the nearest 1 mm using a telescopic height-measuring instrument (model SECA 220). To classify participants as normal weight or overweight (including obese) the gender and age-specific cut-offs according to the International Obesity Task Force were used[22]. Self-reported weight in kilograms and height in meters were used to calculate parents' body mass index and they were also classified as normal weight or overweight (including obese)[23].

Functional profiles factors

Functional independence profile factors were assessed using a specific questionnaire designed by the research group based on Adaptive Behavior Scale-School assessment[24]. The scale was composed of 12-items scored on 4-response categories (1=none, 2 =little, 3=fairly and 4=a lot) about social, routine and autonomy of participants' skills. The factorial structure designed by the research group was assessed using confirmatory factorial analyses and satisfactory adjustment was observed with the dimensional structure: χ^2/gl=1.64; GFI=0.89; CFI=0.94; RMSEA=0.79. Furthermore, the dimensional structure showed satisfactory intra-class correlation (ICC) with values between 0.62 and 0.93 (all $p< 0.001$) as well as high internal consistency reliability with values α entre 0.73 and 0.87.

Familial factors

Eleven familial factors were included in this study. Father and mother education were assessed by a specific question extracted from a questionnaire of the AVENA (Alimentación y Valoración del Estado Nutricional de los adolescentes) study[25], comprised by 5 response categories from "no studies" to "university studies". Father and mother working status were assessed by 13-items scale from "high-level" to "low-level". Perceived parents' availability to take care of their adolescents was assessed using 1-item with 5-response categories from "having little time" to "having a lot of time". This item showed an ICC value of 0.79 in the test-retest reliability ($p<0.001$). Parental support of transportation was assessed by composed of 2-items (i.e. parents usually allow the participants to walk alone for the neighbourhood by their own, parents allow the participants to take the public transportation by their own) with 4-response categories based on the Evenson et al.[26] study. These items showed an ICC value of 0.81 and 0.90 in the test-retest reliability ($p<0.001$), respectively. Perceived importance of PA benefits, assessed by 5-items composed of 5-response categories created by the research group. This set of items showed a moderate to high test-retest reliability assessed by ICC values between 0.54 and 0.83 (all $p< 0.05$). The father and mother PA were assessed by single-item questions about the compliance of PA guidelines for adults (i.e., Do you do vigorous PA at least three times per week or moderate PA al least five times per week?) with 2-response categories (no/yes). The number of siblings was assessed, ranged from 0 to 10-response scale and birth order, based on the number of pregnancies, ranged from "only child" to "ninth born".

Social factors

Nine potential social factors were assessed. Six of them included information about the frequency that their parents, siblings and friends spent watching te-

levision (TV) and doing PA together. Items were scored on a 5-point Likert scale from "never" to "very frequently". Family dietary habits during watching TV was assessed based on a specific item obtained from the HELENA sedentary behavior questionnaire with the question: 'How often do you eat while you watch TV?' using 6 categories response scale from "never" to "several times per day"[27]. The time the participants spent indoor during afternoon-weekdays (Monday to Friday) and weekend days (Saturday and Sunday) was assessed, using 5-point Likert scale from "nothing" to "entire evening".

Home, neighborhood and school environmental factors. Seven home environmental factors were analyzed. Sport facilities at home, assessed by 7-items with 5 response categories ranging from "0" to "4 or more"; home technology equipment and technology at the participants' bedroom, both assessed by 4-items with 7-response categories ranging from "0" to "6 or more". These questionnaires were adapted from a standard survey[28,29]. In addition, specific construction features of participants' home were assessed as the size of the house in square meters, the number of bedrooms and having a garden or terrace at home. Eleven neighborhood and school environmental factors were assessed using the short and adapted version of the environmental questionnaire developed in the European research project Assessing Level of Physical Activity (ALPHA)[30]. This questionnaire was rated on 4-response categories scale for each item from "strongly disagree" to "strongly agree".

Statistical analysis

Given the large number of variables considered as potential correlates of PA in this study, the statistical approach was developed in two steps. In the first step, we conducted analysis of covariance in order to select candidate factors associated with levels of PA, adjusting for participant gender, age and SES. Frequency distributions were calculated for all variables considered as correlates and natural groups for categorical variables and dichotomized groups for ordinal and continue variables (split by the median value in order to obtain similar size groups) where used for comparisons. All levels of PA were checked for normality of distribution before the analysis and transformation were performed when it was necessary. A square rooted transformation was applied for total PA and vigorous PA in order to achieve normality.

In the second step, those factors considered as potential correlates of PA with p value of <0.10 in the analysis of covariance were selected to test their association in a final model, using a stepwise multiple linear regression (p<0.05). We ensure that the final model met the assumptions of linear regression. We explored collinearity between correlates using criteria of a tolerance index of 0.10, variation inflammation factor index of 0.10 and a condition index of 30 or higher to consider the presence of multicollinearity.

Statistical analyses were carried out using IBM SPSS statistical software package (version 19.0, Chicago, IL, USA) for Macintosh. The level of significance was set at p<0.05.

Results

Analysis of covariance

Result from the analysis of covariance was performed to select factors associated with levels of PA. Tables show those significant factors with p value of <0.05 and those selected factors for the final analysis with p value of <0.10. As shown in table I, the selected factors for the final analysis were mother's age, SES and positive health for total PA; participant's age, father age and SES for moderate PA; gender, participant's age, SES and positive health for vigorous PA and participant's age and SES for moderate-to-vigorous PA. As shown in table II, the selected factors were parental support and father PA for moderate PA and moderate-to-vigorous PA, while only father PA was associated with vigorous PA. As shown in table III, the selected factors were TV viewing time with friends for moderate PA, TV viewing time with sibling and weekend time indoor for vigorous PA. As shown in table IV, the only selected factors for the final analysis were home bedroom's number for moderate PA and moderate-to-vigorous PA.

Stepwise multiple linear regression

A stepwise multiple linear regression was performed to evaluate which selected factors were associated with levels of PA (p<0.05). As shown in table V, the regression model shows that SES was negatively associated with total PA (p<0.05). Participant's age, SES and father PA were negatively associated with moderate-to-vigorous PA, while parental support and TV viewing time with friends were positively associated (all p<0.05). Participant's age and father PA were also negatively associated with vigorous PA, while TV viewing time with siblings were positively associated (all p<0.05). Finally, participant's age, SES and father PA were negatively associated with moderate-to-vigorous PA and parental support was positively associated (all p<0.05).

Discussion

This study analyzed potential correlates of objectively measured PA in adolescents with DS. This information can be useful to guide interventions designed to increase levels of PA. Our findings revealed that

Table I
Demographic, health, functional factors of physical activity in adolescents with Down syndrome

	n	*Total PA** (counts/day)	*MPA* (min/day)	*VPA** (min/day)	*MVPA* (min/day)
Demographic factors					
Gender					
Males	63	404 ± 153	48 ± 17	**12** ± 9[1]	59 ± 25
Females	35	367 ± 115	44 ± 16	**9** ± 6	53 ± 20
Participant's age					
≤ 15	47	411 ± 127	**51** ± 17[1]	**15** ± 8[1]	**66** ± 24[1]
≥ 16	51	373 ± 151	**42** ± 16	**7** ± 6	**49** ± 20
Father's age					
≤ 49	47	410 ± 146	49 ± 18	13 ± 9	62 ± 26
≥ 50	45	371 ± 143	42 ± 15	9 ± 7	51 ± 20
Mother's age					
≤ 49	52	**418** ± 131[1]	49 ± 14	13 ± 8	62 ± 20
≥ 50	46	**361** ± 148	44 ± 20	9 ± 8	53 ± 27
SES					
Low-medium	43	**455** ± 165[1]	**53** ± 17[1]	**14** ± 10[1]	**67** ± 2[1]
High	55	**341** ± 94	**42** ± 15	**8** ± 6	**50** ± 20
Health factors					
Positive health					
Regular-good	34	**366** ± 138[1]	45 ± 19	**10** ± 9[1]	55 ± 28
Very good-excellent	58	**405** ± 146	47 ± 16	**12** ± 8	58 ± 21
Participant's BMI					
Normal-weighted	47	384 ± 137	44 ± 15	11 ± 8	54 ± 21
Overweight or obese	51	397 ± 146	49 ± 19	11 ± 9	60 ± 25
Father's BMI					
Normal-weighted	29	413 ± 121	49 ± 14	12 ± 7	61 ± 19
Overweight or obese	59	377 ± 157	45 ± 18	10 ± 9	55 ± 26
Mother's BMI					
Normal-weighted	48	392 ± 138	48 ± 19	11 ± 8	59 ± 26
Overweight or obese	43	391 ± 154	44 ± 13	11 ± 9	55 ± 19
Functional factors					
Social functional					
Low	44	387 ± 144	46 ± 18	12 ± 9	58 ± 25
High	54	395 ± 140	47 ± 16	10 ± 7	57 ± 22
Routine functional					
Low	46	415 ± 155	48 ± 18	13 ± 10	61 ± 25
High	51	371 ± 127	45 ± 16	9 ± 6	54 ± 21
Autonomy functional					
Low	49	398 ± 147	47 ± 18	12 ± 9	59 ± 26
High	48	386 ± 137	46 ± 16	10 ± 7	56 ± 21
Total functional scale					
Low	47	406 ± 152	48 ± 18	14 ± 10	62 ± 26
High	49	380 ± 133	45 ± 16	8 ± 6	54 ± 21

Values are mean ± SD. Abbreviations: PA, physical activity; MPA, moderate PA; VPA vigorous PA; MVPA, moderate to vigorous PA; SES, socio-economic status; BMI, Body mass index (kg/m2). * Values were square-root-transformed before analysis, but the non-transformed values are presented in the table. Statistically significant values, controlling for gender, participant's age and SES, are showed in bold (all $p<0.05$). [1]Selected factors for the final model ($p<0.10$).

Table II
Familial factors of physical activity in adolescents with Down syndrome

	n	*Total PA* (counts/day)*	*MPA (min/day)*	*VPA* (min/day)*	*MVPA (min/day)*
Familial factors					
Father education					
Less than high school	43	411 ± 128	47 ± 16	12 ± 8	59 ± 21
More than high school	47	372 ± 161	44 ± 18	10 ± 9	54 ± 26
Mother education					
Less than high school	38	420 ± 136	50 ± 18	13 ± 9	62 ± 25
More than high school	57	379 ± 139	45 ± 15	10 ± 8	55 ± 21
Father work status					
Low-medium	46	422 ± 152	50 ± 18	14 ± 10	63 ± 25
High – very high	44	361 ± 134	43 ± 17	9 ± 7	52 ± 22
Mother work status					
Low-medium	44	406 ± 126	48 ± 18	12 ± 8	60 ± 24
Very high – high	53	380 ± 153	44 ± 16	10 ± 9	54 ± 22
Adolescents care availability					
Few	69	381 ± 142	46 ± 16	10 ± 8	56 ± 22
Enough-adequate	27	407 ± 141	47 ± 19	12 ± 10	59 ± 26
Parental support					
Low	58	386 ± 134	**46 ± 18[1]**	11 ± 9	**57 ± 25[1]**
High	36	399 ± 154	47 ± 16	10 ± 8	57 ± 22
Parents benefits PA					
Less important	48	400 ± 145	48 ± 19	11 ± 9	59 ± 26
Very important	47	376 ± 140	44 ± 15	11 ± 8	54 ± 21
Father PA					
No	48	413 ± 144	**49 ± 17[1]**	12 ± 9 a	**62 ± 24[1]**
Yes	42	362 ± 144	42 ± 18	9 ± 8	51 ± 24
Mother PA					
No	50	386 ± 149	46 ± 18	11 ± 9	57 ± 26
Yes	47	393 ± 133	47 ± 16	11 ± 8	58 ± 21
Sibling's number					
≤ 1	66	388 ± 134	48 ± 18	11 ± 9	59 ± 25
≥ 2	31	398 ± 159	44 ± 14	10 ± 8	54 ± 19
Birth order					
≤ 1	41	366 ± 103	48 ± 17	11 ± 9	59 ± 25
≥ 2	56	410 ± 163	45 ± 17	11 ± 8	56 ± 22

Values are mean ± SD. Abbreviations: PA, physical activity; MPA, moderate PA; VPA vigorous PA; MVPA, moderate to vigorous PA. * Values were square-root-transformed before analysis, but the non-transformed values are presented in the table. Statistically significant values, controlling for gender, participant's age and SES, are showed in bold (all $p<0.05$). [1]Selected factors for the final model ($p<0.10$).

Table III
Social factors of physical activity in adolescents with Down syndrome

	n	*Total PA* (counts/day)*	*MPA (min/day)*	*VPA* (min/day)*	*MVPA (min/day)*
Social factors					
TV viewing time with parents					
None-little	44	356 ± 129	42 ± 15	9 ± 8	51 ± 21
A lot of	50	416 ± 150	50 ± 18	12 ± 9	62 ± 25
TV viewing time with siblings					
None-little	35	357 ± 127	42 ± 17	9 ± 8 [a]	51 ± 23
A lot of	44	408 ± 151	47 ± 15	12 ± 8	59 ± 21
TV viewing time with friends					
None-little	54	383 ± 152	**44** ± 16[1]	11 ± 8	55 ± 22
A lot of	29	408 ± 128	**51** ± 18	11 ± 9	62 ± 26
PA with parents					
None-little	59	385 ± 141	46 ± 15	10 ± 7	56 ± 20
A lot of	32	396 ± 150	47 ± 20	13 ± 11	56 ± 29
PA with siblings					
None-little	49	384 ± 152	45 ± 16	10 ± 9	55 ± 23
A lot of	30	392 ± 126	47 ± 17	11 ± 6	58 ± 22
PA with friends					
None-little	39	375 ± 134	44 ± 16	10 ± 8	54 ± 22
A lot of	45	405 ± 151	49 ± 17	9 ± 8	60 ± 25
Family dietary habits watching TV					
≤ 2 meals per week	60	387 ± 143	46 ± 16	11 ± 8	56 ± 22
≥ 2 meals per week	36	391 ± 139	47 ± 19	11 ± 8	58 ± 26
Weekly time indoor					
Little time	46	384 ± 137	47 ± 18	10 ± 8	57 ± 25
Much time	45	401 ± 150	46 ± 17	11 ± 9	58 ± 22
Weekend time indoor					
Little time	57	408 ± 138	49 ± 17	12 ± 9[1]	61 ± 23
Much time	37	363 ± 147	43 ± 17	9 ± 8	52 ± 24

Values are mean ± SD. Abbreviations: PA, physical activity; MPA, moderate PA; VPA vigorous PA; MVPA, moderate to vigorous PA; TV, television. * Values were square-root-transformed before analysis, but the non-transformed values are presented in the table. Statistically significant values, controlling for gender, participant's age and SES, are showed in bold (all $p<0.05$). [1]Selected factors for the final model ($p<0.10$).

participant's age and SES were negatively associated with levels of PA as non-modifiable correlates. Moreover, parental support, TV viewing time with siblings and TV viewing time with friends were positively associated with levels of PA, whereas father PA was negatively associated with levels of PA as modifiable correlates. To our knowledge, this is the first study to explore correlates of objectively measured PA in adolescents with DS. A better understanding of correlates of PA could contribute to develop strategies on PA promotion in adolescents with DS.

Age has been previously identified as a consistent non-modifiable correlate associated with PA in adolescents without disabilities[31], and similar results have been also obtained among youths with DS[5,6]. The present study found that participant's age was negatively associated with levels of PA. This finding supports the hypothesis that a decline of PA with age might have a biological basis since it has been consistently identified not only through a wide range of diverse populations but also in animal studies[32].

Table IV
Home, neighbourhood, school environmental factors of physical activity in adolescents with Down syndrome

	n	*Total PA* (counts/day)*	*MPA (min/day)*	*VPA* (min/day)*	*MVPA (min/day)*
Home environmental factors					
Sport facilities at home					
≤ 3	50	378 ± 127	45 ± 15	9 ± 8	54 ± 20
≥ 4	39	418 ± 154	50 ± 18	13 ± 9	64 ± 26
Technology equipment at home					
≤ 8	42	431 ± 151	51 ± 17	13 ± 10	65 ± 25
≥ 9	44	350 ± 130	41 ± 15	8 ± 7	49 ± 20
Participants' bedroom technology					
≤ 1	42	376 ± 135	44 ± 15	10 ± 8	55 ± 21
≥ 2	45	393 ± 130	49 ± 17	11 ± 8	60 ± 24
Participants' bedroom TV					
No	50	379 ± 151	44 ± 16	11 ± 9	54 ± 22
Yes	46	399 ± 133	49 ± 18	11 ± 9	60 ± 25
House sizes square meters					
≤ 120	46	409 ± 129	51 ± 17	12 ± 9	62 ± 24
≥ 121	49	380 ± 152	43 ± 16	10 ± 8	54 ± 22
Home bedrooms' number					
≤ 3	54	416 ± 133	51 ± 17[1]	12 ± 9	62 ± 23[1]
≥ 4	44	361 ± 147	41 ± 16	9 ± 8	51 ± 22
Have garden or terrace					
No	40	414 ± 133	51 ± 18	12 ± 9	63 ± 25
Yes	49	373 ± 153	42 ± 15	10 ± 8	52 ± 22

Values are mean ± SD. Abbreviations: PA, physical activity; MPA, moderate PA; VPA vigorous PA; MVPA, moderate to vigorous PA; TV, television. * Values were square-root-transformed before analysis, but the non-transformed values are presented in the table. Statistically significant values, controlling for gender, participant's age and SES, are showed in bold (all $p<0.05$). [1]Selected factors for the final model ($p<0.10$).

Evidence regarding the association of SES with PA in adolescents without disability reported mixed results depending on whether PA is measured objectively (e.g. accelerometry) or subjectively (e.g. questionnaires). For example, some studies found negatively association between SES and levels of PA when PA was measured by accelerometery[36], while no association[8,31] or a positive association[37] were found when PA was measured by self-reported. The results of our study are in concordance with studies of adolescents without disabilities when PA was measured by accelerometry. Discrepancies between these studies might be due to different definitions and measures of SES and also the specific component of the PA measured. For example, De Cocker et al.[38] found that only self-reported walking time was higher among those with low and medium SES while self-reported vigorous PA was higher among those adolescents with medium and high SES.

Previous reviews in adolescents without disabilities have produced mixed results[9,31,39]. Some have concluded that parental modeling, support and encouragement are positively associated with young's PA whilst others have showed unclear or no association of familial factors with PA[40]. In adolescents with intellectual disability or DS, there is a lack of studies regarding familial influence and PA. Only one study examined the association of familial factors and PA in adolescents with intellectual disabilities reporting that caregiver's preference of PA could significantly predict regular PA[41]. Our results showed that parental support was positively associated with PA, whereas parental modeling (e.g. father PA) was negatively associated with levels of PA. This result suggest that parental support may influence on levels of PA in adolescents with DS since this population has a greater dependence of their parents or caregivers due to their cognitive limitations. However, the evidence regarding parent modeling

Table IV
(Continued) Home, neighbourhood, school environmental factors of physical activity in adolescents with Down syndrome

	n	*Total PA* (counts/day)*	*MPA (min/day)*	*VPA* (min/day)*	*MVPA (min/day)*
Neighbourhood / school factors					
Item 1: Abundance of houses					
Less agreement	43	408 ± 155	49 ± 19	12 ± 10	61 ± 27
Greater agreement	49	364 ± 128	43 ± 14	10 ± 8	53 ± 21
Item 2: Nearby shops and walkable					
Less agreement	35	340 ± 104	43 ± 16	9 ± 6	51 ± 20
Greater agreement	60	414 ± 153	48 ± 18	12 ± 9	60 ± 25
Item 3: Nearby public transport stops					
Less agreement	73	384 ± 147	46 ± 17	10 ± 8	56 ± 23
Greater agreement	19	405 ± 127	48 ± 19	13 ± 10	60 ± 28
Item 4: Alternative paths					
Less agreement	49	372 ± 132	44 ± 16	10 ± 8	53 ± 23
Greater agreement	46	402 ± 149	49 ± 17	12 ± 8	61 ± 24
Item 5: Traffic insecurity					
Less agreement	67	388 ± 145	47 ± 18	11± 9	57 ± 25
Greater agreement	29	390 ± 134	45 ± 13	11 ± 8	56 ± 19
Item 6: Neighbourhood security					
Less agreement	39	340 ± 151	46 ± 15	12 ± 8	58 ± 21
Greater agreement	57	381 ± 135	46 ± 19	10 ± 9	57 ± 25
Item 7: Pleasant environment					
Less agreement	48	396 ± 139	48 ± 18	11 ± 9	59 ± 24
Greater agreement	48	382 ± 145	44 ± 16	11 ± 8	55 ± 22
Item 8: Sport equipment					
Less agreement	44	420 ± 161	50 ± 18	12 ± 10	62 ± 25
Greater agreement	52	362 ± 118	43 ± 16	10 ± 7	53 ± 21
Item 9: Active conmmuting to school					
Less agreement	62	363 ± 124	44 ± 15	10 ± 7	54 ± 20
Greater agreement	28	418 ± 162	47 ± 18	12 ±9	58 ±25
Item 10: School sports facilities					
Less agreement	40	379 ± 135	45 ± 15	11 ± 8	56 ± 21
Greater agreement	53	388 ± 143	46 ± 16	10 ± 8	55 ± 22
Total score					
Less agreement	42	389 ± 141	47 ± 15	11 ± 8	58 ± 21
Greater agreement	45	374 ± 142	42 ± 16	10 ± 8	52 ± 22

Values are mean ± SD. Abbreviations: PA, physical activity; MPA, moderate PA; VPA vigorous PA; MVPA, moderate to vigorous PA. * Values were square-root-transformed before analysis, but the non-transformed values are presented in the table. Statistically significant values, controlling for gender, participant's age and SES, are showed in bold (all $p<0.05$). [1]Selected factors for the final model ($p<0.10$).

Table V
Correlates of physical activity in adolescents with Down syndrome analyzed by stepwise multiple linear regression

	β	P	Adj. R^2	β	P	Adj. R^2	β	P	Adj. R^2	β	P	Adj. R^2
			Total PA (counts/day)*			*MPA (min/day)*			*VPA* (min/day)*			*MVPA (min/day)*
			0.092			0.346			0.368			0.365
n	92			81			75			94		
Participant´s age	-	-		-0.419	<0.001		-0.526	<0.001		-0.485	<0.001	
SES	-0.319	0.002		-0.264	0.007		-	-		-0.267	0.002	
Parental support	-	-		0.336	0.001		-	-		0.287	0.002	
Father PA	-	-		-0.203	0.029		-0.224	0.019		-0.233	0.006	
TV viewing time with siblings	-	-		-	-		0.203	0.032		-	-	
TV viewing time with friends	-	-		0.199	0.036		-	-		-	-	

Abbreviations: PA, physical activity; MPA, moderate PA; VPA, vigorous PA; MVPA, moderate to vigorous PA; SES, socio-economic status; TV, television. * Values were square-root-transformed before analysis. Statistically significant values are showed in bold (all p<0.05).

should be further examined because it is likely that adolescents with DS might not be able to copy parent behavior due to their low autonomy.

Another finding in our study was the positively association between TV viewing time and levels of PA. This finding could seem an unexpected finding because PA and sedentary behaviors (as TV viewing time) are usually interpreted as opposite behaviors. However, previous studies have shown that there is null or weak association between both behaviors in youth without disabilities[9,39,42], which means that they are independent behaviors. The findings of our study could be explained in terms of social interactions. It is likely that those adolescents with DS who have more frequently interactions with peers (sibling or friend) during leisure sedentary activities (e.g. TV viewing time) have more opportunities to interact with each other in active behaviors (e.g. spontaneous active playing).

Previous researches have found that environmental factors were associated with PA in adolescents without disabilities. For example, a present review pointed out that the most robust built environment correlates of PA are land-use mix and residential density[43]. However, our data suggest that neighborhood environmental correlates are not associated with levels of PA in adolescents with DS. A possible explanation of this lack association is that adolescents with DS are not allowed to move by their own in the neighborhood due to their reduced autonomy and greater parents' dependence.

To develop effective PA interventions in adolescents with DS, it is relevant to understand correlates and determinants of PA. Data from this study identified only two non-modifiable correlates (participants' age and SES) and four modifiable correlates (parental support, father PA, frequency of TV viewing time with siblings and with friends) were associated with levels of PA in adolescents with DS. This finding may suggest that both non-modifiable and modifiable correlates have an impact on levels of PA in adolescents with DS, but more attention should point toward modifiable factors for increasing levels of PA.

This study had several limitations and strengths. Limitations included: (i) cross-sectional design, thus, cause effect cannot be inferred; (ii) correlates of PA were reported by proxy-respondent due to cognition limitation of adolescents with DS; (iii) accelerometers cannot measure aquatic activities, which could influence measured PA in adolescents with DS; (iv) the lack rigorously validated questionnaire for parents with /or adolescents with DS to assess potential factors that could be influencing levels of PA is a weakness in our study. Strengths include: (i) relatively large and homogeneous sample of adolescents with DS; (ii) the use of accelerometer to measure objectively PA; (iii) the assessment of the large number of potential correlates across several domains (demographic, personal, environmental, etc.).

In conclusion, the results of our study suggest that few correlates may influences levels of PA in adoles-

cents with DS. In addition, the key modifiable correlate might contribute to develop strategies on PA promotion specifically addressed to youth with DS. However, further researches are needed on the role of factors associated with PA since this issue is almost unexplored in this population.

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