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Tracking of Physical Activity from Childhood to Adulthood: A Review

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Key Words
Tracking · Obesity · Physical activity · Childhood · Adulthood

Summary
The aim of the article was to review studies on the tracking of physical activity in all phases of life from childhood to late adulthood. The majority of the studies have been published since 2000. The follow-up time in most studies was short, the median being 9 years. In men, the stability of physical activity was significant but low or moderate during all life phases and also in long-term follow-ups. In women, the tracking was lower and in many cases non-significant. Among both sexes, stability seems to be lower in early childhood than in adolescence or in adulthood and lower in transitional phases, such as from childhood to adolescence or from adolescence to adulthood, than in adulthood. However, the differences in the stability of physical activity between age groups and between different phases of life were small. The number of tracking studies utilising objective methods to measure physical activity was so small that systematic differences in stability between self-report and objective methods could not be determined. A factor which caused differences in tracking results was the adjustment of correlations for measurement error and other error variance. Adjusted coefficients were clearly higher than unadjusted ones. However, adjustment was done only in very few studies. If the different methods used for estimating habitual physical activity and the failure to control for important covariates in studies of tracking are taken into account, physical activity appears to track reasonably well also in the longer term, for example from adolescence to adulthood. The results of the tracking studies support the idea that the enhancement of physical activity in children and adolescents is of great importance for the promotion of public health.

Introduction

The promotion of public health through physical activity interventions is based on the belief that physical activity is habitual and thus rather stable, in other words, it tracks over time. Tracking is usually defined as a tendency of individuals to maintain their rank or position within a group over time [1]. Tracking also means the ability to predict subsequent observations on the basis of earlier values [2]. The tracking of physical activity is especially important from the viewpoint of physical education. Nowadays, one of the most common aims of physical education in a great many countries is the promotion of a physically active lifestyle and life-long physical activity [3]. If successful, the enhancement of a physically active lifestyle should be trackable over long periods, such as from childhood to adulthood. If it is expected that physical activity at a young age, e.g. in school physical education or in youth sport, will have a favourable effect on public health, a high level of physical activity in youth should predict a high level of physical activity in adulthood.

Because many transitions and life-changing events experienced during the course of life influence physical activity, the level of tracking of physical activity is likely to vary at different phases of life. Therefore, information about the tracking of physical activity at different phases of life would be useful in the planning of interventions. On the one hand, tracking is a positive phenomenon. We hope that active children will also be active in adulthood and that new activities adopted in physical education and in interventions are maintained in the

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years to come. On the other hand, tracking has also a negative side. We know that some young people in all populations are inactive, which means, if the level of tracking is high, they will also be inactive later. Therefore, as pointed out by Corbin [4], it is important to emphasise the 'un-tracking' of inactivity and, in general, to keep the focus on the tracking of inactivity in tracking studies. Here, the concept inactivity means also very low activity and is not parallel with sedentary behaviour which is not necessarily a part of the physical activity continuum. The tracking of sedentary behaviour is not a topic of this review.

Because tracking means the tendency of individuals to maintain their rank or position within a group over time, the most often used indicator of tracking is Spearman's rank order correlation. Another method of showing tracking is to divide the distribution of physical activity into tertiles, quartiles, quintiles etc. and to show by cross-tabulation how individuals have stayed in the same position over time. Tracking coefficients show the stability or amount of variability of physical activity over long intervals of time. However, physical activity also varies over short intervals, e.g. from day to day or season to season, thus also influencing the tracking correlation. Therefore, more important than the type of tracking coefficient used is the adjustment of coefficients for error and short-term variance, which is not part of the concept of tracking.

Table 1. Longitudinal tracking studies

Reference	Number of participants	Tracking from age … to	Assessment of physical activity	Tracking coefficient		
				all	male	female
Tracking in childhood and in adolescence						
Jackson et al., 2003 [8]	60	3–4	accelerometer	0.40		
Pate et al., 1996 [10]	47	3–6	heart rate	0.57		
Sallis et al., 1995 [7]	288	4–6	direct observation	0.27		
Kelly et al., 2007 [9]	42	4–6	accelerometer	0.35–0.37		
Hallal et al., 2006 [6]	634	4–10	mother report, questionnaire	significant tracking		
Oja and Jürimae, 2001 [5]	294	6–8	mother report		NS	NS
Nyberg et al., 2009 [11]	97	7.5–9	Actiwatch		0.72	0.51
Raudsepp and Päll, 1998 [12]	42	8–10	Caltrac accelerometer	0.34–0.57		
Kristensen et al., 2008 [22]	444	9–15	MTI actigraph:			
			crude		0.18	0.19
			adjusted		0.53	0.48
Telama et al., 1994 [51]	465	9–15	short questionnaire		0.34	0.21
	503	12–15			0.51–0.53	0.42–0.48
McMurray et al., 2003 [19]	791	9–16	questionnaire		0.18–0.37	0.23–0.26
Janz et al., 2000 [18]	126	10–15	interview VPA		0.32	0.43
Pate et al., 1999 [20]	181	11–14	previous day recall:			
			VPA		0.23	0.23
			Kcal		0.38	0.25
Bagget et al., 2008 [13]	951	12–14	actigraph			0.25–0.33
			3-D self-report			0.17–0.22
Raudsepp et al., 2008 [14]	345	12–14	3-day recall:			
			METs		0.36	0.42
			VPA		0.40	0.30
Raustorp et al., 2007 [17]	96	13–18	pedometer:			
			3 years		0.55	NS
			5 years		0.35	NS
Aarnio et al., 2002 [16]	2,934	16–18	short questionnaire		0.56	0.44
Tracking in adulthood						
Fortier et al., 2001 [26]	>1,000	15–69	questionnaire	0.04–0.39		
Telama et al., 2005 [27]	1,563	18–27	questionnaire		0.61	0.31
		18–30			0.44	0.39
		18–33			0.35	0.42
		18–36			0.43	0.29
		18–39			0.33	0.26
De Bourdeaudhuij et al., 2002 [25]	172	20–27	questionnaire		NS	0.34–0.41

Table 1 to be continued on next page

Table 1. Continued

Reference	Number of participants	Tracking from age … to	Assessment of physical activity	Tracking coefficient		
				all	male	female
Parsons et al., 2006 [31]	9,769	23–42	questionnaire		0.16	0.12
		23–33			0.20	0.11
Anderssen et al., 1996 [24]	5,115	24–31	interview		0.42–0.49	0.34–0.41
Friedman et al., 2008 [29]	449	25–66	questionnaire		0.15	0.13
	689	39–66			0.22	0.16
	628	49–66			0.21	0.24
Sallis et al., 2001 [30]	226	31–38	interview			0.30
Kirjonen et al., 2006 [28]	546	40–68[a]	interview physical activity		0.19	0.18
		40–50[a]	time		0.25	0.29
		40–45[a]			0.46	0.34
Tudor-Locke et al., 2008 [23]	1,175	42–43	pedometer		0.54–0.65	0.20–0.61
Mulder et al., 1998 [74]	1,400	50–54	questionnaire	0.25–0.38		
Armstrong and Morgan, 1998 [75]	1,042	65–73	questionnaire:			
			outdoor activity		0.50	0.58
			walking		0.45	0.18
			strength activity		0.49	0.56
Tracking from young age to adulthood						
Richards et al., 2007 [21]	829	7–21	family report and interview	0.09		
		9–21		0.11		
Telama et al., 2005 [27]	1,563	9–30	questionnaire		0.35	0.17
		9–27			0.28	NS
		9–24			0.31	0.21
Trudeau et al., 2004 [32]	166	9–35	diary	0.20		
Parsons et al., 2006 [31]	9,769	11–42	questionnaire		0.03	NS
		16–42			0.09	0.07
Friedman et al., 2008 [29]	1,277	11–66	parent report, questionnaire		0.14	0.12
Herman et al., 2008 [37]	374	12–27[b]	questionnaire		significant	significant
		12–34[b]			NS	NS
Telama et al., 2005 [27]	1,563	12–33	questionnaire		0.33	0.23
		15–36			0.44	NS
		18–39			0.33	0.26
Anderssen et al., 2005 [34]	455	13–21	questionnaire, (WHO)		0.15	0.09
Twisk et al., 2000 [76]	181	13–27	interview GEE	0.34		
Vanreusel et al., 1997 [56]	236	13–35	interview	0.14–0.20		
Scheerder et al., 2006 [44]	257	13–35	questionnaire			NS
		16–35				0.41
Tammelin et al., 2003 [42]	7,794	14–31	questionnaire	significant prediction		
Beunen et al., 2004 [39]	166	14–40	questionnaire		NS	
		16–40			0.22	
Boreham et al., 2004 [35]	268	15–22	questionnaire		0.20	NS
Engström, 1991 [41]	2,000	15–30	questionnaire	significant		
Glenmark et al., 1994 [36]	105	16–27	questionnaire R2		0.28	0.66
Barnekow-Bergkvist, 1998 [38]	278	16–34	questionnaire		0.28	0.27
Matton et al., 2006 [43]	138	16–41	questionnaire sport participants			NS
Andersen et al., 1993 [33]	202	17–25	questionnaire, 1-year recall		0.31	NS
Scott and Willits, 1989 [40]	1,298	adolescents >50	questionnaire		0.14	0.25

NS = Not significant.
[a]40 is mean age at baseline, range 18–68 years.
[b]12 is mean age at baseline, range 7–18 years.

Malina [1] published his often cited review on the tracking of physical activity in 2001. Interest in the tracking of physical activity has increased notably since then. The majority of longitudinal tracking studies have been published after 2000, and articles published during the last few years show that the activity in this field continues unabated (table 1). Not only has the number of tracking studies increased after 2001 but there is also a qualitative development in the field indicated, e.g. by the use of objective methods of measuring physical activity and more sophisticated methods to analyse tracking. The aim of this article is to review physical activity tracking studies. The main focus is on longitudinal studies but some retrospective studies have also been included especially when the question addressed is how well previous physical activity predicts current activity. The search words used were tracking/stability and physical activity/sport participation. The data bases were PubMed and SportDiscus. Only articles available in English were accepted. The follow-up time in the reviewed studies ranged from 1 to 55 years, with a median of 9 years. Below, the tracking results are discussed in three categories: tracking in childhood and adolescence, in adulthood, and from childhood and adolescence to adulthood. Because many different statistical procedures and methods to measure or assess physical activity have been used, the coefficients presented in the text and in table 1 are only partially comparable.

Tracking of Physical Activity in Childhood and Adolescence

Only a few studies have reported on the stability of physical activity among pre-school age children. In a study in which 6-year-old children's physical activity measured through mother's report was followed over 18 months, the most tracking correlations were not significant [5], while in another study, also using mother's estimation of physical activity, the level of tracking from age 4 to 6 was significant [6]. Direct observation of physical activity from age 4 to 6 also showed a significant but low correlation of tracking ($r = 0.27$) [7]. The studies using more objective methods to measure physical activity have reported a somewhat higher level of tracking across follow-up of a few years: in two studies using an accelerometer, r was 0.35–0.40 [8, 9], and in a study with heart rate recording, r was 0.57 [10]. It seems that some stability, at least on a low or moderate level, exists in young children's physical activity when the measurement validity is high enough. Accelerometer measurements during the first school years show a somewhat higher stability of physical activity than measurements in pre-school age [11, 12].

At least five studies have investigated the tracking of physical activity during the adolescent years. From studies using 3-day self-report with the same follow-up time, from 12 to 14 years, one reported low tracking (0.17–0.22) [13] and another one moderate tracking (0.30–0.42) [14]. A Finnish study following adolescents over 3 years from age 12 to 15 presented correlations in two cohorts of 0.51 and 0.53 for boys and 0.42 and 0.48 for girls. The stability coefficients attenuated for reliability by the Simplex model were 0.65 and 0.72 for boys and 0.53 and 0.68 for girls [15]. Another study applying a short questionnaire resulted in a tracking correlation over 2 years of 0.56 for boys and 0.44 for girls [16]. Physical activity determined by a pedometer showed a tracking coefficient of 0.55 over 3 years and 0.35 over 5 years in boys, whereas in girls the correlations were non-significant [17].

The transition from childhood to adolescence is interesting from the viewpoint of physical education and the development of lifestyle. Studies based on self-report measures have reported low or moderate tracking from childhood to adolescence of 0.13–0.43 [18–21]. Also, the tracking of physical activity measured with an accelerometer was found to be very low, from 0.18 to 0.19 from the age 10–12 to 14–16, but was higher (boys 0.53, girls 0.48) when the coefficients were adjusted for random error due to day-to-day variation and within instrumental measurement error [22].

Tracking of Physical Activity in Adulthood

An Australian study reported moderate or moderately high tracking over 1 year when physical activity was measured by a pedometer over 7 days, with r varying from 0.52 to 0.65, with the exception that in one female cohort r was 0.34 [23]. There were no clear differences between age groups from 30 to 60 years. Three studies reported on the stability of physical activity among young adults (18–32) over 7 years. The tracking coefficients varied from 0.35 to 0.42 in female participants and from 0.35 to 0.49 in male participants, with one study showing a non-significant relationship for male subjects [24–26]. The correlations for comparable age groups in a Finnish study over 9 years were 0.61 for male and 0.31 for female participants from age 18 to 27 and 0.58 and 0.51 from age 21 to 30, respectively [27]. In another Finnish study, stability over 5 years in 18- to 64-year-olds was 0.46 and 0.34 for male and for female subjects, and stability over 10 years was 0.25 and 0.29, respectively [28]. The 4-year tracking correlation in an American study from age 25 to 29 was 0.21 for both sexes [29], and another American study showed a correlation of 0.30 in a follow-up of female participants from age 31 to 38 [30]. Few studies have reported long-term tracking correlations in adulthood. In a Finnish study among 18- to 64-year-olds, the tracking correlation over 28 years was 0.19 for male and 0.18 for female participants. Here, the correlation may be influenced by the dropout of older participants due to mortality [28]. In the Young Finns Study, the tracking correlation over 21 years for 18- to 39-year-olds was 0.33 for men and 0.26 for women [27].

Tracking from Childhood and Adolescence to Adulthood

The tracking of physical activity from childhood to adulthood has been shown to be very low or non-significant. From age 11 to 42, the correlation was only 0.03 for men and non-significant for women [31], 0.20 from age 8 to 34 among both sexes [32], and from age 9 to 30 it was 0.35 in male and 0.17 in female subjects [27]. The correlation for sport club participation from age 7 to 21 was 0.09 and from 9 to 21 it was 0.11 in a group of boys and girls [21].

The majority of published tracking studies concerns the period from adolescence to adulthood. The tracking coefficients from adolescence to young adulthood (<30 years) for male subjects varied from 0.15 to 0.44 [27, 33–36]. One study on men reported a non-significant relationship [26]. Only a few studies have reported significant tracking correlations from adolescence to young adulthood for female participants, the coefficients ranging from 0.09 to 0.34 [27, 34, 37]. In addition, one study found that physical activities at age 16 strongly predicted physical activity at age 27 among female participants, $r = 0.66$ [36]. Three studies reported non-significant tracking from adolescence to young adulthood among women [26, 33, 35]. Tracking of physical activity from adolescence to young adulthood seems to be low or non-significant, especially in female participants.

The coefficients showing the stability of physical activity from adolescence to adulthood at age ≥30 vary from 0.14 to 0.44 among men [27, 38–40]. Only one non-significant relationship was found in male subjects [37]. Among female participants, the corresponding coefficients varied from 0.23 to 0.41 [27, 38, 40]. Two studies reported a significant relationship for both sexes [41, 42]. In three studies, a non-significant relationship was found in at least one age cohort in female participants [27, 43, 44]. A significant relationship between adolescent and adult physical activity has also been confirmed by retrospective studies [45–48]. Among men, the long-term stability of physical activity from adolescence to adulthood seems to be low but significant. In female participants, the many non-significant relationships indicate poorer stability compared to men.

One study, based on very old data, found a significant relationship between physical activity at age 11 and 67: $r = 0.14$ for male and 0.12 for female participants [29]. This very long stability of physical activity has been supported by retrospective studies [49, 50].

Factors Related to Tracking

Among the many factors affecting the tracking of physical activity, the follow-up time, method of assessing physical activity, gender and age of subjects, and type of physical activity will be discussed here. The influence of the follow-up time cannot be seen from the overview, as this concerns different age groups, different measurement methods, and subjects from different cultural environments. When the baseline age was 18 and the same method was used to assess physical activity in a Finnish population, the tracking correlation for male participants varied according to the follow-up time as follows: 3 years 0.58, 6 years 0.50, 9 years 0.47, 12 years 0.44, 15 years 0.35, 18 years 0.43, and 21 years 0.33. The respective correlations for female participants were 0.48, 0.42, 0.41, 0.39, 0.42, 0.29, and 0.26. The first three coefficients concerned the same individuals. The other figures represented different age cohorts [27, 51]. The decline in the coefficients along follow-up time is rather linear, however, here it is also important to take the possible influence of life changes in young adulthood into account.

The differences found in stability between the measurement methods were not large when the tracking time was the same. However, it must be remembered that objective methods of measurement have been used in rather few studies. In pre-school age children, objective methods, such as the use of an accelerometer or heart rate recording, have shown higher stability than, for example, mother's estimation or direct observation. Otherwise it is difficult to see systematic differences between objective and recall methods. One reason for the similarity between self-report and objective methods may be that although objective methods measure physical activity more accurately during the measurement itself, their ability to capture a sufficient sample of the individual's activities or day-to-day variation may be lower than that of self-report. Recording usually covers a few days or, at most, 1 week. The self-report method in turn may better capture on various activities, including, for instance, seasonal variation, but involves a larger measurement error than is the case in objective methods due to difficulties in recalling or estimating one's own behaviour. In any case, objective methods should be used in the study of the stability of physical activity and attention should be paid to the adequate coverage of time and activities in recording.

A gender difference was clearly seen in the results of the physical activity tracking studies. Tracking coefficients were in many cases lower and more often non-significant in women than in men. One reason may be the lower participation rate among female than among male subjects. Another reason may be connected with the major transitions in the course of life, such as the transition from schooling to employment or from singlehood to marriage and having children, experiencing unemployment etc., which may influence physical activity and its stability. In adulthood, the gender difference in the stability of physical activity may be caused by the fact that many life changes have a greater influence on the physical activity of women than men [52, 53]. The gender differences in tracking may also be explained by the changes in opportunities for physical activity among women, especially related to fitness centres.

Although it can be reasonably expected that the stability of physical activity will be different due to different developmental phases and various transitions in different phases of life, it is difficult to see any systematic age differences in the tracking coefficients reported in the reviewed studies. When physical activity was assessed with the same self-report method in four age groups, the tracking correlations over 3 years were 0.50, 0.53, 0.66, and 0.67 for 9-, 12-, 15-, and 18-year-old male subjects and 0.47, 0.48, 0.57, and 0.58 for female subjects, respectively, in both cases showing a slight growth with age. However, the growth of correlations with age disappeared when the correlations were corrected for reliability, which was lower in the younger than in the older groups [15]. In order to study age differences in the real stability of physical activity, the objective method should be used in different age groups drawn from the same population. Tudor-Locke et al. [23] studied tracking over 1 year in a large adult population aged from 20 to >60 and found no systematic age differences, with the exception that in women >60 years the correlation was lower (0.30) than it was in the other groups (average for men 0.57 and for women 0.55).

The level of reliability and tracking of physical activity seems to vary according to the type of activity. In particular, organised activities, such as participation in a youth sport programme, are easier to recall than unorganised recreational activities because organised activities generally follow a regular timetable. The tracking of the item concerning participation in sport club training was found to be better than the tracking of other items in a physical activity inventory [15, 51]. A rather high tracking coefficient (general estimation equation, GEE) for sport club participation from childhood to young adulthood was also found in a study in New Zealand [21]. Other variables that are easy to recall and which have been found to be good predictors of adult physical activity are participation in sport competitions and physical education grade in school [36, 41, 45, 49, 54].

The tracking of physical activity means that it is a good thing for physical education and public health when active individuals maintain their level of activity. However, tracking of physical inactivity or low activity is in turn clearly less desirable. There is some evidence that inactivity tends to track better than activity [17, 34, 43, 55–57]. In future research, more emphasis should be paid to the tracking of inactivity and, in general, to those who are inactive, as pointed out by Corbin [4].

In his review, Malina [1] mentioned the cultural background as a possible factor affecting the tracking of physical activity. As an example he presented higher level tracking results from Finland and from other Nordic countries as compared to results from the USA and some other countries. Cultural context was also mentioned in a Norwegian study as a possible factor for influencing the tracking of physical activity concerning recreational outdoor activity in particular [57]. In Norway, most adolescents have daily access to nature, recreation parks, and outdoor activity areas. The same can be said about the cultural context in Finland. No statistical analysis on the differences in tracking of physical activity between different cultural contexts has been carried out for this review because of the different follow-up times, methods of assessment of physical activity, and age groups. However, a non-systematic overview may give some support to cultural differences, in particular among women.

What Is behind Tracking?

Why do some people maintain their physical activity over long time periods while others stay inactive? Physical education and other measures to promote an active lifestyle are based on expectations that physical activity will be maintained to some extent in the long term. From the viewpoint of developing promotional measures it is important to know what factors explain or are connected with the tracking of physical activity during adulthood or from school age to adulthood. If, for instance, tracking is mainly explained by genetic factors, measures to enhance a physically active lifestyle will not be so effective. Four approaches to this issue are discussed here: the ‘carry-over value hypothesis’, ‘ability and readiness hypothesis’, ‘habit formation hypothesis’, and ‘self-selection hypothesis’.

The carry-over value hypothesis presented by physical educators suggests that in adulthood people continue to participate in the activities they engaged in at a young age. Therefore, such lifestyle activities should be taught in school [58–60]. The tracking of the same type of physical activity from school age to adulthood has been little studied. A Finnish study showed that adolescents who participated in endurance type of sport or in women’s gymnastics also had a higher probability of participating in the same kinds of activities 17 years later [61]. A similar relationship between adolescent and adult participation was found in many activities in a Norwegian study in which the follow-up time was only 8 years [57]. A retrospective study has reported a similar relationship for swimming [62]. In some activities, participation at a young age may increase the probability of participation in adulthood but otherwise adult physical activity does not seem to depend on the type of activity practised in youth. The typical sport activities practised at a young age and in adulthood are generally different. Playing soccer or ice hockey regularly in youth predicted high physical activity in adulthood in Finnish males although rather few of them continued to play soccer or ice hockey in adulthood [27, 61]. A recent Norwegian study showed that the number of activities participated in during adolescence is more important for the later physical activity than the participation in any specific activities [57]. Thus, the carry-over hypothesis explains a part of the tracking from young age to adulthood but cannot be the main explanation of the tracking of physical activity in general.

It has been found that those who have participated persistently in physical activity or organised sport in youth for >3 years much more often belong to the highest tertile of physical activity in adulthood 21 years later than those who were inactive at a young age or those who did not participate in youth sport [27, 63]. Organised youth sport has also been found to be a good predictor of adult physical activity in other longitudinal studies [38, 41, 64, 65] and in retrospective studies [45–49]. These findings that, in particular, persistent intensive physical activity and participation in organised sport predicts best adult physical activity independent of the types of sports engaged in at a young age suggest that regular, intensive, and persistent participation results in the development of motor abilities, skills, attitudes, and motivation, all of which are important for later physical activity. This is called here the ability and readiness hypothesis, meaning that earlier experiences of physical activities and sports and of the basic skills connected with them make it easy to maintain physical activity or start it again after a possible break, even though the type of activity practised is different.

The habit formation hypothesis says that people repeat some behaviour because it is a habit, which means, for example, that participation in physical activity is not only based on planned behaviour and intention but is done rather automatically and with less awareness [66–68]. In order to form a habit, a lot of repetition of behaviour is needed. However, habit is something more than frequency of behaviour and can be distinguished from behaviour frequency. It is easy to understand that part of the physical activity behaviours, such as daily walks, daily home gymnastics, and commuting in a physically active way, are based on habits. We know very little about the tracking of habits from young age to adulthood, and therefore it is difficult to estimate the importance of the habit formation hypothesis as an explanation for the tracking of physical activity. The review showed that low activity or inactivity tracks better than activity. It may be that inactivity is more often based on a habit than high level of activity.

The self-selection hypothesis should also be taken into account as a possible explanation for the tracking of physical activity. It posits that those individuals who have a hereditary disposition to fitness and motor performance participate more often in physical activity both at a young age and in adulthood than those who do not have the same disposition. It is known that physical fitness is to a considerable extent genetically determined [69, 70], which gives some support to the self-selection hypothesis. Family and twin studies have shown high or moderate genetic influences on sport participation and leisure time physical activity [71, 72]. Research data showing a direct relationship between genes and physical activity in animals are still missing in humans [73]. As Rankinen and Bouchard [73] state, research on genetics, physical activity, and health is still in its infancy, but there is already substantial evidence to conclude that physical activity affects the health status and to recognize that genomes modulate the associations between activity and health at multiple levels. Although it is evident that genes regulate fitness and other physiological bases of physical activity to a large degree, it seems that genetics explains only a part of physical activity behaviour.

Discussion

The results of this review of the tracking studies show physical activity to have significantly low or moderate stability during all life phases and also in long-term follow-ups in men. In women, the level of tracking is lower and in many studies non-significant. In both sexes, stability seems to be lower in early childhood than in adolescence or in adulthood and lower in transitional phases, such as from childhood to adolescence or from adolescence to adulthood, than in adulthood. Especially in adolescence, the tracking is influenced by the growth which happens at a different time in different individuals. However, the differences in the stability of physical activity between age groups and between different phases of life were small. The number of tracking studies implemented using objective methods to measure physical activity was so small that systematic differences in stability could not easily be seen between self-report and objective methods. One factor which made a difference in the tracking results was the adjustment of correlations for measurement error and other error variance. Adjusted coefficients were clearly higher than unadjusted ones. Unfortunately, adjustment was done only in very few studies.

A big problem in many tracking studies is the lack of information about the validity and reliability of the assessment of physical activity. In addition to reporting the reliability of measurement, it would be important to correct stability correlations for measurement error by employing reliability information. One reason for the low tracking correlations is just the poor reliability because tracking cannot be higher than reliability if not corrected. It is highly desirable that objective methods are used in tracking studies because of their better validity and reliability compared with self-report methods. However, also data obtained using objective methods often need some correction procedures to improve the reliability and validity of the measurement instrument. Short-term variation in physical activity from day to day or between weekdays and weekend, although reliably measured with an accelerometer, means error variance when the tracking of physical activity is concerned. Also, seasonal variation can be seen as error variance from the viewpoint of long-term tracking (e.g. tracking from adolescence to adulthood). Therefore, tracking coefficients should be adjusted to take this kind of variation into account.

In spite of the large number of tracking studies, our knowledge about the tracking of physical activity is rather limited. In addition to paying more attention to the adjustments of tracking correlations for different error variations, factors influencing tracking also need to be included in study designs. A longitudinal study involves a lot of effort and resources, and therefore it would only be reasonable to obtain all the information possible about the covariates of tracking and not to look merely at the inter-age correlations. There is evidence that low physical activity or inactivity tracks better than high activity. Because physical inactivity is a big problem confronting public health policy, special attention should be paid to the tracking of inactivity and, in particular, to the determinants of inactivity. Especially important regarding this is the continuous increase of obesity among young people.

Since Robert Malina's review on the tracking of physical activity in 2001 [1], the quantity of tracking studies has greatly increased along with a slight increase in their quality. It is still possible to agree with his conclusion: 'Allowing for the different methods for estimating habitual physical activity, change associated with normal growth and maturation, and lack of control for important covariates in studies of tracking, physical activity tracks reasonably well from childhood to young adulthood'. In the light of the results reviewed here, the conclusion can also be extended to the tracking in the longer term. This supports the idea that the enhancement of children's and adolescents' physical activity is genuinely important from the standpoint of public health.

Disclosure

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