This is a self-archived version of an original article. This version may differ from the original in pagination and typographic details.

Author(s): Jantunen, H.; Wasenius, N. S.; Salonen, M. K.; Perälä, M.-M.; Kautiainen, H.; Simonen, M.; Pohjolainen, P.; Kajantie, E.; von Bonsdorff, Mikaela; Eriksson, J. G.

Title: Relationship between physical activity and physical performance in later life in different birth weight groups

Year: 2018

Version: Accepted version (Final draft)

Copyright: © Cambridge University Press and the International Society for Developmental Origins of Health and Disease

Rights: In Copyright

Rights url: <http://rightsstatements.org/page/InC/1.0/?language=en>

Please cite the original version:

Jantunen, H., Wasenius, N. S., Salonen, M. K., Perälä, M.-M., Kautiainen, H., Simonen, M., Pohjolainen, P., Kajantie, E., von Bonsdorff, M., & Eriksson, J. G. (2018). Relationship between physical activity and physical performance in later life in different birth weight groups. *Journal of Developmental Origins of Health and Disease*, 9(1), 95-101.
<https://doi.org/10.1017/S2040174417000575>

Relationship between physical activity and physical performance in later life in different birth weight groups

Hanna Jantunen¹²³, Niko S. Wasenius¹², Minna K. Salonen⁴, Mia-Maria Perälä⁴, Hannu Kautiainen², Mika Simonen⁵, Pertti Pohjolainen⁶, Eero Kajantie⁴⁷⁸, Mikaela B. von Bonsdorff¹⁹, Johan G. Eriksson¹²⁴

¹Folkhälsan Research Center, Helsinki, Finland

²Department of General Practice and Primary Health, Care and Helsinki University Hospital, University of Helsinki, Helsinki, Finland

³Centre of Expertise for Health and Work Ability, Finnish Institute of Occupational Health, Helsinki, Finland

⁴Chronic Disease Prevention Unit, National Institute for Health and Welfare, Helsinki, Finland

⁵Finnish Centre of Excellence in Intersubjectivity in Interaction, University of Helsinki, Helsinki, Finland

⁶Age Institute, Helsinki, Finland

⁷Children's Hospital, Helsinki University Hospital and University of Helsinki, Helsinki, Finland

⁸PEDEGO Research Unit, MRC Oulu, Oulu University Hospital and University of Oulu, Oulu, Finland

Abstract

There is strong evidence that physical activity (PA) has an influence on physical performance in later life. Also, a small body size at birth has been associated with lower physical functioning in older age and both small and high birth weight have shown to be associated with lower leisure time physical activity. However, it is unknown whether size at birth modulates the association between PA and physical performance in old age. We examined 695 individuals from the Helsinki Birth Cohort Study born in Helsinki, Finland between 1934 and 1944. At a mean age of 70.7 years PA was objectively assessed with a multisensory activity monitor and physical performance with the Senior Fitness Test (SFT). Information on birth weight and gestational age was retrieved from hospital birth records. The study participants were divided in three birth weight groups i.e. <3000 g, 3000-3499 g and ≥3500 g. The volume of PA was significantly associated with the physical performance in all birth weight groups. However, the effect size of the association was large and significant only in men with a birth weight <3000 g (β 0.59 95% confidence interval 0.37-0.81, $p < 0.001$). Our study shows that the association between PA and physical performance is largest in men with low birth weight. Our results suggest that men with low birth weight might benefit most from engaging in PA in order to maintain a better physical performance.

Keywords: Aging, Birth weight, Physical activity, Physical performance

Introduction

According to the developmental origins of health and disease (DOHaD) hypothesis non-optimal growth during prenatal life can have long-term health consequences later in life.¹

Low birth weight (LBW) has been associated with all-cause mortality as well as an increased risk of developing type 2 diabetes and coronary heart disease later in life.²⁻⁷ LBW has also been linked with altered skeletal muscle fiber composition⁸ and decreased muscle strength in adult life.⁹⁻¹¹ These conditions are risk factors for decreased physical functioning in old age¹² and one study has shown positive association between LBW and lower general health-related physical functioning at older age.¹³ However, there are also studies that have shown inconsistent evidence on low birth weight and measures of physical performance in adulthood.^{14, 15} Although LBW has been shown to be associated with lower leisure time physical activity (LTPA)^{16, 17}, there are also studies which have not observed an association of LBW and inactivity.^{18, 19} Andersen et al. also showed that the association between birth weight and LTPA is U-shaped, both low and high birth weight being associated with lower probability of undertaking LTPA.¹⁷ Physical activity (PA) is important in maintaining physical performance^{20, 21} as well as in preventing several chronic non-communicable diseases.²² As the life expectancy increases as well as the number of people surviving to very old age, preserving adequate physical functioning is becoming an important global health issue. Further, it is crucial in preserving independency and coping with daily tasks.²³

We have previously shown in a Finnish birth cohort, the Helsinki Birth Cohort Study (HBCS) that the volume of objectively measured PA among older people was positively associated with their physical performance measured with a validated fitness test battery (Senior Fitness Test, SFT).²⁴ To our knowledge no previous study has explored the interaction between body size at birth and PA on physical performance in old age. By identifying those who benefit the most from PA in preserving physical performance, it helps us in targeting the promotion of PA. The aim of this study was to assess whether birth weight modifies the effect size of the association between PA and physical performance.

Methods

Study population and measures

The subjects in this study belong to the Helsinki Birth Cohort Study (HBCS) including 13,345 individuals born in Helsinki between 1934 and 1944. In the year 2000, a random sample of subjects from the HBCS was invited to participate in a clinical examination conducted between the years 2001 and 2004.¹¹ From the first clinical study cohort (n=2003) 142 of the participants had died by 2011. People who were alive and living within 100 km distance from the study clinic in Helsinki (n=1404) were invited to participate in a new clinical examination. 1094 participants attended the second clinical examination between 2011 and 2013.²⁵ 1078 of these completed the SFT and 714 of these also were willing to participate in the PA measurement. Nineteen participants did not have information on educational attainment. Therefore 695 individuals (316 men and 379 women) were included in the study.²⁴

PA was objectively measured between 2012 and 2013 using the Sense-Wear Pro 3 Armband (SWA) (BodyMedia, Inc., Pittsburg, PA, USA). The SWA has been shown to be valid for assessing energy expenditure in free-living conditions²⁶ and the energy expenditure estimated by the SWA correlates strongly with estimates from doubly labelled water and indirect calorimetry also in elderly people (r 0.48, p <0.01).²⁷ The SWA is a multisensory body monitor that is worn on the triceps of the right arm and it combines information from a biaxial accelerometer and several physiological parameters such as skin temperature, near-body temperature, heat flux and galvanic skin response. This information is integrated with the individual's demographic characteristics and processed by a software to provide minute-by-minute estimates of energy expenditure. We used the Innerview Sensewear Professional Software (version 6.1) for analyses. SWA based PA was expressed as the metabolic equivalents of task (MET) and MET values were multiplied with time (hours) to calculate MET-hours. The study population was instructed to wear the SWA for 10 consecutive days, also when sleeping and to take off the SWA only when showering, bathing or swimming.

Participants with valid data from at least four weekdays and one weekend day were included in the study. A valid day consisted of day with at least 1296 min data (90 % of 24-h period). The volume of physical activity was expressed as average MET-hours per day.

At the clinical examination physical performance was assessed by using the validated SFT²⁸ between 2011 and 2013. We used a modified test battery consisting of five components of the SFT; number of chair stands in 30 s to assess lower-body strength; number of bicep curls in 30 s while holding a hand weight to assess upper-body strength; chair sit and reach to assess the lower-body flexibility; number of meters walked in 6 min to measure aerobic endurance and back scratch to assess upper-body flexibility. The result of each test was expressed as age (for each 5-year group) and sex standardized percentile scores and an overall test score was calculated by summarizing the normalized scores of the five SFT components.

Measurements of weight and height at birth and information on gestational age (last menstrual period of mother) were retrieved from hospital birth records. The participants were measured for weight and height at the clinical examination. Body mass index (BMI) was calculated as weight in kilograms divided by square of height in meters (kg/m^2). Lean body mass (LBM) and body fat was assessed with bioelectrical impedance by using the InBody 3.0 eight-polar tactile electrode system (Biospace Co., Ltd., Seoul, Korea). Participants' smoking habits were assessed by questionnaires and smoking status was expressed as years of smoking. Individually linked data on educational attainment (years of studying) was obtained from Statistics Finland.

Statistical analyses

Analyses were conducted separately for men and women as the developmental programming has shown to be different in men and women.²⁹ We divided the study population in three categories according to their birth weight, <3000 g, 3000-3499 g and ≥ 3500 g. Statistical comparisons between birth weight groups were conducted by using

analysis of variance (ANOVA) and between men and women in different birth weight groups with Student's *t* test. Linear regression analyses were used to identify the appropriate predictors of the physical performance using unadjusted and adjusted (age, gestational age, educational attainment and smoking) standardized regression coefficients Beta (β). The Beta value is a measure of how strongly each predictor variable influences the criterion (dependent) variable. The beta is measured in units of standard deviation. Cohen's standard for Beta values above 0.10, 0.30 and 0.50 represent small, moderate and large relationships, respectively.³⁰ A possible nonlinear relationship between METh and the SFT were assessed by quadratic regression models. The significance level was set at $p < 0.05$. We also undertook sensitivity analyses to test the associations between the volume of physical activity with different components of SFT (chair stand, arm curl, chair sit and reach, six-minute walk and back scratch tests). The analyses were adjusted for age, gestational age, educational attainment and smoking. The analyses were carried out with Stata 14.1, StataCorp LP (College Station, TX, USA) statistical package.

Results

Table 1 shows descriptive characteristics of the study population according to birth weight separately for men and women. Mean age of the participants was 70.7 years. Women whose birth weight was ≥ 3500 g were significantly taller ($p < 0.001$) in adulthood and their LBM was significantly higher ($p < 0.001$) than for women with birth weight was < 3500 g. Otherwise weight, height, BMI, LBM or body fat percentage in adulthood did not differ significantly between the birth weight groups.

The volume of PA in older age did not differ statistically significantly between birth weight groups. In men, the mean SFT score was higher in the higher birth weight groups, but these associations were not statistically significant ($p = 0.15$ in men and $p = 0.74$ in women). In each

birth weight group women performed better in SFT compared to men ($p=0.002-0.039$). On the contrary men had greater volume of PA in the 3000-3499 g ($p=0.002$) and ≥ 3500 g ($p=0.039$) birth weight groups compared to women. The difference was not significant in those with a birth weight <3000 g ($p=0.873$).

Figure 1 shows the associations between the volume of PA and the SFT score in the three birth weight groups separately for men and women. Figure 2 presents the associations between the volume of PA and the SFT score adjusted for age, gestational age, educational attainment and smoking years. The volume of PA was significantly associated with the SFT score both in men and women in each of the three birth weight groups. However, only in men whose birth weight was <3000 g the association was large based on Cohen's standard (β 0.59 95% confidence interval 0.37-0.81, $p<0.001$). In table 2, the associations between physical activity and the different components of SFT in different birth weight groups are shown in men and women separately. In men belonging to the birth weight group <3000 g, the association was constantly stronger in chair stand, arm curl, chair sit and reach, and back scratch test. In the 6 minute walk test there were no difference between birth weight groups in men or in women. In the other test components in women there were not a consistency in the strength of associations between birth weight groups.

Discussion

We observed that the effect size of the association between PA and physical performance in later life is modified by body size at birth. We stratified the study group by birth weight and in both genders and in each birth weight group the volume of PA was associated with the physical performance in older age. However, only in men belonging to the lowest birth weight group the association was large. The interpretation of our findings suggests that men with LBW might benefit most from engaging in PA in order to maintain a better physical performance.

In this study the volume of PA did not differ significantly between birth weight groups.

However, when comparing men and women in the two heaviest birth weight groups men had significantly greater total volume of PA than women. The mean SFT score was higher in the higher birth weight groups, but the differences between the groups were not statistically significant. These results are in line with a previous study in the same cohort showing that lower weight at birth predicted lower general health-related physical functioning ten years earlier at a mean age 62 years.^{13, 31} Women had better physical performance scores in every birth weight group compared to men.

When testing different test components of SFT, we found that the results were in accordance with the overall SFT with all other test components than six-minute walk test. In chair stand, arm curl, chair sit and reach and back scratch tests the association between volume of PA with these SFT components was constantly stronger in men with birth weight <3000 g. In women there was not such a consistency of the strength of the associations between different birth weight groups. In line with a previous study³² in the same birth cohort reporting no significant association between size at birth and cardiorespiratory fitness (UKK 2-km walk test) there were no difference in the strength of associations of volume of PA and six min walk test results between birth weight groups in men or in women. Effect size being larger in the overall SFT result than in the test components of it supports focusing on the overall SFT result.

The DOHaD hypothesis proposes that the prenatal period largely influences the health and wellbeing of an individual.³³ In utero malnutrition results in physiological adaptations in structure, metabolism and endocrine functions and increases the susceptibility to adult diseases. When the nutrients provided to a fetus are limited, the fetus tries to conserve energy to the growth of key organs, such as the brains, at the expense of other tissues. Birth size serves as a marker of the intrauterine environment. LBW can, however, be a result of preterm birth or slow growth in utero. Because of this and since we wanted to focus on the effects of slow prenatal growth, we adjusted the analyses for gestational age.

LBW is associated with lower LBM¹¹, lower muscle mass and altered skeletal muscle fiber composition⁸ and with decreased muscle strength across the life course.⁹ Prenatal undernutrition may result in permanent reduction in both the size and number of muscle fibers.³⁴ As the number of muscle fibers decreases with age a deficit in the muscle fibers reserve established at birth may predispose to premature decline in physical performance. Muscle weakness in midlife has been shown to predict functional limitations and disability 25 years later.¹² On the other hand a study has demonstrated that weight gain in childhood was beneficial for midlife physical performance suggesting that the interventions to increase muscle mass in early life may have beneficial effects on physical performance in adulthood.¹⁴ LBW has been linked to obesity¹¹ and reduced cardiopulmonary capacity.³⁵ These features can reduce the willingness to engage in PA and are risk factors for lower physical performance. LBW has also been associated with other poor health outcomes¹, which can be linked with limited physical performance. In addition, there is evidence that personality factors may also be determined in utero³⁶ and can thus have an influence on the relationship between birth weight and adult health outcomes.

The strengths of our study include a well-characterized birth cohort with birth data obtained from reliable hospital records. Further strengths are objectively measured PA and assessment of physical performance was done using a validated physical performance test battery.

The limitations of HBCS have been previously discussed.⁴ The participants of the study were both born and attended child-welfare clinics in the city of Helsinki. As the attendance to the clinics was voluntary, the study population may not be representative of all people living in Helsinki. As some of the individuals included in this cohort were born during the Second World War, families might have suffered from food shortages. These results might have been affected also by a survival effect among those with better physical performance. Individuals who participated in the clinical examination in 2011-13 were younger, thinner, more educated had a healthier diet in 2001-2004 than those who did not participate in the follow-up. There

might have been also a selection bias as the participation in the SFT requires a certain level of physical fitness and those with severe functional limitations excluded from the study.

Those who participated in the PA measurement had significantly better overall SFT result and also succeeded better in other test components than chair sit and reach and back scratch. Because the setting of the study was cross-sectional the direction of causality remains uncertain. But since there is a large body of evidence on the importance of PA in maintaining good physical performance it supports our interpretation of the result.

In conclusion, our study suggests that influences during prenatal life can have long-term effects on health that can be partly predicted by the size of a newborn. In our study the association between PA and physical performance in old age was most obvious among men with LBW. Individuals who are small at birth might especially benefit from PA in preserving their physical performance in later life. As birth weight is not easily modifiable, more focus should be put on enhancing active lifestyles among aging people in order to preserve good physical performance, independency and quality of life as long as possible. Even more important is taking care of pregnant women's adequate health and nutrition status. In addition, as the function of the placenta has a significant impact on birth weight, we should also try to diminish the risk of placental insufficiency.

Acknowledgements

We thank the volunteers for taking the time to participate in the clinical study and the research nurses for carrying out the clinical examinations.

Financial Support

Helsinki Birth Cohort Study was supported by grants from British Heart Foundation; Finska Läkaresällskapet; Samfundet Folkhälsan; Juho Vainio Foundation; Signe and Ane Gyllenberg Foundation; The Diabetes Research Foundation; Finnish Foundation for

Cardiovascular Research and EU H2020-PHC-2014-DynaHealth (grant no. 633595). The Academy of Finland supported M.B.v.B. (grant no. 257239) and J.G.E. (grant nos 129369, 129907, 135072, 129255 and 126775). The funding sources had no role in the study design, collection, analysis or interpretation of the data or writing of the report.

Conflicts of Interest

None.

Ethical Standards

The clinical study protocol was approved by the Ethics Committee of Epidemiology and Public Health of the Hospital District of Helsinki and Uusimaa. Written informed consent was obtained from each participant before any study procedure was initiated.

References

1. Barker DJ. Adult consequences of fetal growth restriction. *Clin Obstet Gynecol*. 2006 Jun;49(2):270-83.
2. Eriksson JG, Osmond C, Kajantie E, Forsen TJ, Barker DJ. Patterns of growth among children who later develop type 2 diabetes or its risk factors. *Diabetologia*. 2006 Dec;49(12):2853-8.
3. Barker DJ, Hales CN, Fall CH, Osmond C, Phipps K, Clark PM. Type 2 (non-insulin-dependent) diabetes mellitus, hypertension and hyperlipidaemia (syndrome X): relation to reduced fetal growth. *Diabetologia*. 1993 Jan;36(1):62-7.
4. Barker DJ, Osmond C, Forsen TJ, Kajantie E, Eriksson JG. Trajectories of growth among children who have coronary events as adults. *N Engl J Med*. 2005 Oct 27;353(17):1802-9.
5. Barker DJ, Osmond C, Golding J, Kuh D, Wadsworth ME. Growth in utero, blood pressure in childhood and adult life, and mortality from cardiovascular disease. *BMJ*. 1989 Mar 4;298(6673):564-7.
6. Risnes KR, Vatten LJ, Baker JL, Jameson K, Sovio U, Kajantie E, et al. Birthweight and mortality in adulthood: a systematic review and meta-analysis. *Int J Epidemiol*. 2011 Jun;40(3):647-61.
7. Baker JL, Olsen LW, Sorensen TI. Weight at birth and all-cause mortality in adulthood. *Epidemiology*. 2008 Mar;19(2):197-203.
8. Jensen CB, Storgaard H, Madsbad S, Richter EA, Vaag AA. Altered skeletal muscle fiber composition and size precede whole-body insulin resistance in young men with low birth weight. *J Clin Endocrinol Metab*. 2007 Apr;92(4):1530-4.

9. Dodds R, Denison HJ, Ntani G, Cooper R, Cooper C, Sayer AA, et al. Birth weight and muscle strength: a systematic review and meta-analysis. *J Nutr Health Aging*. 2012 Jul;16(7):609-15.
10. Sayer AA, Syddall HE, Gilbody HJ, Dennison EM, Cooper C. Does sarcopenia originate in early life? Findings from the Hertfordshire cohort study. *J Gerontol A Biol Sci Med Sci*. 2004 Sep;59(9):M930-4.
11. Yliharsila H, Kajantie E, Osmond C, Forsen T, Barker DJ, Eriksson JG. Birth size, adult body composition and muscle strength in later life. *Int J Obes (Lond)*. 2007 Sep;31(9):1392-9.
12. Rantanen T, Guralnik JM, Foley D, Masaki K, Leveille S, Curb JD, et al. Midlife hand grip strength as a predictor of old age disability. *JAMA*. 1999 Feb 10;281(6):558-60.
13. von Bonsdorff MB, Rantanen T, Sipila S, Salonen MK, Kajantie E, Osmond C, et al. Birth size and childhood growth as determinants of physical functioning in older age: the Helsinki Birth Cohort Study. *Am J Epidemiol*. 2011 Dec 15;174(12):1336-44.
14. Kuh D, Hardy R, Butterworth S, Okell L, Richards M, Wadsworth M, et al. Developmental origins of midlife physical performance: evidence from a British birth cohort. *Am J Epidemiol*. 2006 Jul 15;164(2):110-21.
15. Martin HJ, Syddall HE, Dennison EM, Cooper C, Sayer AA. Physical performance and physical activity in older people: are developmental influences important? *Gerontology*. 2009;55(2):186-93.
16. Elhakeem A, Cooper R, Bann D, Kuh D, Hardy R. Birth Weight, School Sports Ability, and Adulthood Leisure-Time Physical Activity. *Med Sci Sports Exerc*. 2017 Jan;49(1):64-70.

17. Andersen LG, Angquist L, Gamborg M, Byberg L, Bengtsson C, Canoy D, et al. Birth weight in relation to leisure time physical activity in adolescence and adulthood: meta-analysis of results from 13 nordic cohorts. *PLoS One*. 2009 Dec 16;4(12):e8192.
18. Pinto Pereira SM, Li L, Power C. Early-life predictors of leisure-time physical inactivity in midadulthood: findings from a prospective British birth cohort. *Am J Epidemiol*. 2014 Dec 1;180(11):1098-108.
19. Ridgway CL, Brage S, Sharp SJ, Corder K, Westgate KL, van Sluijs EM, et al. Does birth weight influence physical activity in youth? A combined analysis of four studies using objectively measured physical activity. *PLoS One*. 2011 Jan 12;6(1):e16125.
20. Fried LP, Guralnik JM. Disability in older adults: evidence regarding significance, etiology, and risk. *J Am Geriatr Soc*. 1997 Jan;45(1):92-100.
21. Paterson DH, Warburton DE. Physical activity and functional limitations in older adults: a systematic review related to Canada's Physical Activity Guidelines. *Int J Behav Nutr Phys Act*. 2010 May 11;7:38,5868-7-38.
22. Lee IM, Shiroma EJ, Lobelo F, Puska P, Blair SN, Katzmarzyk PT, et al. Effect of physical inactivity on major non-communicable diseases worldwide: an analysis of burden of disease and life expectancy. *Lancet*. 2012 Jul 21;380(9838):219-29.
23. Vaughan L, Leng X, La Monte MJ, Tindle HA, Cochrane BB, Shumaker SA. Functional Independence in Late-Life: Maintaining Physical Functioning in Older Adulthood Predicts Daily Life Function after Age 80. *J Gerontol A Biol Sci Med Sci*. 2016 Mar;71 Suppl 1:S79-86.

24. Jantunen H, Wasenius N, Salonen MK, Perala MM, Osmond C, Kautiainen H, et al. Objectively measured physical activity and physical performance in old age. *Age Ageing*. 2016 Nov 3.
25. Perala MM, von Bonsdorff M, Mannisto S, Salonen MK, Simonen M, Kanerva N, et al. A healthy Nordic diet and physical performance in old age: findings from the longitudinal Helsinki Birth Cohort Study. *Br J Nutr*. 2016 Jan 20:1-9.
26. St-Onge M, Mignault D, Allison DB, Rabasa-Lhoret R. Evaluation of a portable device to measure daily energy expenditure in free-living adults. *Am J Clin Nutr*. 2007 Mar;85(3):742-9.
27. Colbert LH, Matthews CE, Havighurst TC, Kim K, Schoeller DA. Comparative validity of physical activity measures in older adults. *Med Sci Sports Exerc*. 2011 May;43(5):867-76.
28. Rikli RE, Jones JC. Development and Validation of a Functional Fitness Test for Community-Residing Older Adults. . *Journal of Aging and Physical Activity*. 1999;7(2):129,-161.
29. Aiken CE, Ozanne SE. Sex differences in developmental programming models. *Reproduction*. 2013 Jan 8;145(1):R1-13.
30. Cohen J. A power primer. *Psychol Bull*. 1992 Jul;112(1):155-9.
31. Eriksson JG, Osmond C, Perala MM, Salonen MK, Simonen M, Pohjolainen P, et al. Prenatal and childhood growth and physical performance in old age-findings from the Helsinki Birth Cohort Study 1934-1944. *Age (Dordr)*. 2015 Dec;37(6):108,015-9846-1. Epub 2015 Oct 24.

32. Salonen MK, Kajantie E, Osmond C, Forsen T, Yliharsila H, Paile-Hyvarinen M, et al. Developmental origins of physical fitness: the Helsinki Birth Cohort Study. PLoS One. 2011;6(7):e22302.
33. Barker DJ. Fetal origins of coronary heart disease. BMJ. 1995 Jul 15;311(6998):171-4.
34. Maltin CA, Delday MI, Sinclair KD, Steven J, Sneddon AA. Impact of manipulations of myogenesis in utero on the performance of adult skeletal muscle. Reproduction. 2001 Sep;122(3):359-74.
35. Lawlor DA, Cooper AR, Bain C, Davey Smith G, Irwin A, Riddoch C, et al. Associations of birth size and duration of breast feeding with cardiorespiratory fitness in childhood: findings from the Avon Longitudinal Study of Parents and Children (ALSPAC). Eur J Epidemiol. 2008;23(6):411-22.
36. Raikkonen K, Pesonen AK. Early life origins of psychological development and mental health. Scand J Psychol. 2009 Dec;50(6):583-91.

Table 1 Characteristics of the study population

	<3000 g		3000-3499 g		≥3500 g		
Men	n=39		n=130		n=147		
	Mean	SD	Mean	SD	Mean	SD	<i>p</i>
Age (y)	71.3	2.4	70.7	2.7	70.4	2.5	0.10
Weight (kg)	82.8	11.3	82.6	12.2	84.2	14.1	0.58
Height (cm)	174.9	6.6	175.9	6.0	177.1	6.1	0.09
BMI (kg/m ²)	27.1	3.5	26.7	3.6	26.8	4.1	0.85
Lean body mass (kg)	62.2	6.8	63.0	7.3	64.3	8.1	0.20
Body fat percentage (%)	24.5	5.8	23.3	5.4	23.0	6.3	0.39
Volume of PA (METh/d)	29.7	4.1	30.8	4.8	30.5	4.3	0.38
SFT test result (Sum Score)	39.7	17.1	43.0	16.5	45.3	16.9	0.15
Birth weight (g)	2662.3	253.1	3277.4	131.6	3877.0	319.0	<0.001
Gestational age (d)	271.5	10.7	278.1	11.3	281.9	8.9	<0.001
Women	n=74		n=150		n=155		
	Mean	SD	Mean	SD	Mean	SD	<i>p</i>
Age (y)	71.1	2.6	70.7	2.7	70.9	2.7	0.64
Weight (kg)	68.6	11.2	70.6	11.8	74.0	13.8	0.05
Height (cm)	161.7	6.2	161.3	5.4	163.7	5.6	<0.001
BMI (kg/m ²)	26.3	4.7	27.1	4.3	27.6	5.2	0.16
Lean body mass (kg)	44.6	4.7	45.2	5.2	47.7	5.3	<0.001
Body fat percentage (%)	34.3	7.0	35.2	6.1	34.6	7.1	0.59
Volume of PA (METh/d)	29.5	5.0	29.0	5.1	28.6	5.6	0.50
SFT test result (Sum Score)	47.8	16.8	48.2	17.7	49.5	18.4	0.74
Birth weight (g)	2754.1	203.3	3221.0	141.0	3810.1	244.0	<0.001
Gestational age (d)	277.3	11.9	279.4	10.2	283.3	9.7	<0.001

^aDifference between birth weight groups

Abbreviations: SD, standard deviation; PA, physical activity; MET, metabolic equivalents of task

Figure 1 The associations (quadric polynomial regression fit) between physical activity (MET_h) and physical performance (standardized SFT) in different birth weight groups men and women separately. The grey area gives 95 per cent intervals.

Figure 2 The associations between physical activity and SFT result adjusted with age and gestational age in different birth weight groups men and women separately (β -values with 95% confidence intervals). The dash line shows suggested threshold for large effect size.