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Childhood body mass index and development of type 2 diabetes throughout adult life – a large-scale Danish cohort study

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Contribution statement EZ, JLB and TIAS conceived the study, and all authors were involved in the design of the study. EZ, LGB, and MG did the statistical analysis. All authors were involved in the data interpretation. EZ, LGB, and JLB drafted the manuscript. All authors critically revised the manuscript for important intellectual content and approved the final version of this manuscript. EZ and JLB had full access to all the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis.

What is already known about this subject?

- Studies on limited numbers of youths with type 2 diabetes (<1558 cases per study) suggest that very high body mass index (BMI; kg/m^2) values increase the risk of type 2 diabetes in adulthood
- Birth weight has non-linear associations with adult type 2 diabetes, and these differ between women and men
- It is unclear if associations between childhood BMI and type 2 diabetes differ between women and men and if they are influenced by birth weight

What this study adds

- In a large-scale study including 19,020 diagnosed cases of type 2 diabetes, we investigated associations between childhood BMI across the full range of BMI values and adult type 2 diabetes separately in men and women and the influence of birth weight
- Childhood BMIs above average are strongly associated with type 2 diabetes in adulthood among men and women, underscoring the deleterious effect of excess childhood weight even at levels below international definitions of overweight
- Associations are stronger in women than men, but they are not modified by birth weight in either sex

Abstract

Objective: We investigated how a wide spectrum of BMI values at ages 7-13 years are associated with type 2 diabetes throughout adulthood, including potential modifying effects of sex and birth weight.

Methods*:* From the Copenhagen School Health Records Register we followed 292,827 individuals, born 1930-1983, in national registers for type 2 diabetes (women, n=7472; men, n=11 548). Heights and weights were measured at ages 7-13 years.

Results: Below-average BMIs, with few exceptions, were not associated with type 2 diabetes. Above-average BMIs had positive associations that were stronger in women than men, stronger in younger birth cohorts and weaker with older age-at-diagnosis. Women born 1930-1947, 1948-1965, and 1966-1983 with above-average BMIs at 13 years ($\geq$18.2 kg/m^2) had hazard ratios (95% confidence intervals) ranging from 2.12 (1.91-2.36) to 2.84 (2.31-3.49) per z-score, when diagnosed at 30-47 years. Birth weight did not modify these associations.

Conclusions: Childhood BMIs below average are not associated with type 2 diabetes, whereas childhood BMIs above average are strongly associated with type 2 diabetes in adulthood, corresponding to excess risks even at levels below international definitions of overweight. The associations are stronger in women than men, but are not affected by birth weight.

Introduction

The incidence of type 2 diabetes is rising in many countries, including Denmark.[1] This epidemic may, to some extent, be explained by improved and earlier disease detection combined with lowering of diagnostic thresholds.[1] However, given the clear links between obesity and type 2 diabetes,[2] secular trends in overweight and obesity among children and adults during this time period are likely part of the explanation.[3]

Previous investigations of associations between body size and type 2 diabetes have generally found that individuals with low or high birth weight[4] and older children and adolescents with high body mass index (BMI; kg/m^2) values have increased risks of this disease.[5-13] Although widely recognized that the incidence rate of type 2 diabetes is lower in women than men, stronger associations between high adult BMI and type 2 diabetes are found in women.[14-16] Only a few studies in children, however, examined the associations separately by sex,[6,9,11] which is likely important as a Finnish study found that child BMI was associated with adult type 2 diabetes, but only among women.[9] Previous studies of children were based on selected populations of moderate size and primarily born in the first half of the 20th century and with limited numbers of type 2 diabetes cases. Moreover, it was uncommon that BMI was investigated across the full range of values; most studies focused on categorical comparisons between children above the 75th, 90th or 95th percentiles with those below this value. The aim of this study was to examine associations between childhood BMI and adult type 2 diabetes in a large cohort with long-term follow-up, and to investigate potential sex differences and the influence of birth weight.

Methods

The Copenhagen School Health Records Register contains computerized school health examination information on virtually every schoolchild (n=372 636) from Copenhagen who was born between 1930 and 1989.[17] For children born from 1936 onwards, birth weight was reported by the parents at the first school health examination. Children underwent mandatory school-based health examinations at ages 7 to 13 years, and annual height and weight measurements performed by school doctors or nurses. Children were measured without shoes and either naked or wearing underwear.[17] Basic information was systematically recorded on unique health records.[17] After 1983, measurements were only taken at school entry and exit, or more frequently for children with special needs. In 1968, every Danish citizen was assigned a personal identification number and it was recorded on the health records or retrieved later for children who left school before 1968.[17]

Childhood BMI was calculated and transformed to z-scores using the Lambda Mu Sigma method based upon an internal reference.[17,18] The use of z-scores allows for comparisons of BMI measures across ages by sex. Information on hospital-based diagnoses of type 2 diabetes was retrieved via linkage using identification numbers to the National Patient Registry (NPR).[19] This register contains discharge diagnoses for all individuals discharged from somatic hospitals in Denmark since 1977 and outpatient and emergency departments since 1995.[19] In Denmark, patients with type 2 diabetes are often diagnosed by general practitioners, and since the NPR only includes diagnoses made in patients referred to hospitals, the total population-based incidence of diagnosed type 2 diabetes will be higher than observed in this study. Vital status was obtained from the Danish Civil Registration System.[20]

Type 2 diabetes was defined by the International Classification of Disease (ICD) 8th revision until 1994 (code 250) and the 10th revision thereafter (E11-E14). In Denmark, type 1 diabetes could only be distinguished from type 2 from 1987 when the ICD-8 code 249 (insulin-dependent diabetes mellitus) was introduced. Prior to this, the ICD-8 code 250 included both types. To reduce potential misclassification, the lower age bound for diagnosis of type 2 diabetes was set to 30 years, as most individuals with type 1 diabetes are diagnosed before this age.[21]

Individuals were followed prospectively in registers from 1977 or 30 years of age, whichever came later. Among individuals eligible for analysis (Figure S1), follow up began on January 1, 1977 or at 30 years of age and ended on the date of a type 2 diabetes diagnosis, death, emigration, loss to follow-up, or December 31, 2013, whichever came first.

The study was approved by the Danish Data Protection Agency. According to Danish law, informed consent is not required for purely register-based research of pre-existing personal data.

Statistical analysis

To investigate associations between childhood BMI at each age from 7 to 13 years and the first hospital-based diagnosis of type 2 diabetes in adulthood, we estimated hazard ratios (HR) and 95% confidence intervals (CI) with age as the timescale using Cox proportional hazards regressions. All models were stratified by 1-year birth cohorts.

Deviations from linearity in the associations between childhood BMI and type 2 diabetes were examined using piecewise linear splines with three knots. Subsequent model reduction to a knot at the 50th percentile, corresponding to an average BMI z-score of 0, adequately described the associations. Therefore, the slopes (estimated by the HR) of the associations with type 2 diabetes were estimated for BMI z-scores, included as a continuous variable, below and above this knot point. Potential differences in associations between childhood BMI and type 2 diabetes by sex, across years of birth (tertiles: 1930-1947, 1948-1965, 1966-1983), and by categories of age-at-diagnosis (tertiles: 30-47, 48-65, 66-83 years) were tested in nested models with and without cross-product terms.

Potential interactions between birth weight and BMI and the effects of adjusting for birth weight were investigated in a sub-sample of 222 178 individuals with available information (Table S1, Figure S2).

Sensitivity analyses were conducted by repeating all analyses using the Danish National Diabetes Register, in which date of inclusion is a valid proxy for date of diagnosis from 1995 onwards.[1] It defines diabetes broadly by including information from the NPR, the National Health Service Register (chiropody treatments and blood glucose measurements) and the Danish National Prescription Registry (purchase of oral glucose-lowering drugs).[1] This register was not used as the main source of outcome information for several reasons. Although the completeness of the Diabetes Register is high, it includes up to 20% false-positive registrations because of frequent glucose measurements for reasons other than diabetes.[22] Moreover, type 1 and type 2 diabetes cannot be distinguished from each other in this register.[1] Follow-up began on January 1, 1995 or 30 years of age, whichever came later.

To illustrate potential contributions of contemporary levels of childhood overweight and obesity on type 2 diabetes, we estimated population attributable fractions (PAFs) using the International Obesity Task Force (IOTF) sex-specific overweight and obesity classifications for 13-year-old children.[23] Current levels of overweight and obesity for Western European children were obtained from the Global Burden of Disease Study.[3]

P-values below 0.05 were considered statistically significant. Analyses were conducted in STATA version 12.1 (StataCorp LP, College Station, TX, USA).

Results

During about 7.5 million person-years of follow-up 7472 women and 11 548 men were diagnosed with type 2 diabetes. As expected, mean childhood BMIs and standard deviations increased significantly, although only slightly across birth years from 1930 to 1983 (Table 1). The frequency of type 2 diabetes increased with age in both sexes, but was lower among women than men (chi-square = 840.1, df=1, $P < 0.001$) at all ages from 30 to 83 years (Figure S3).

Childhood BMI z-scores below average were not consistently associated with adult type 2 diabetes in women or men. The associations did not differ between the sexes (all p-values ≥0.11), by birth cohort (all p-values ≥0.11) or age-at-diagnosis (all p-values ≥0.05). There were increased risk estimates of type 2 diabetes at lower BMIs at some ages, mostly at 7 and 8 years, however, this only applied to a few combinations of birth cohort and age-at-diagnosis (Tables 2 and 3, Tables S2 and S3).

In contrast, at all childhood ages above-average BMI values were continuously and positively associated with type 2 diabetes. For above-average BMIs, the hazard ratios were stronger in women than men (all p-values ≤0.03), and they differed by birth cohort (all p-values ≤0.05 in women, ≤0.006 in men), and age-at-diagnosis (all p-values ≤0.001 in women, ≤0.002 in men). In women and men, the associations were stronger in more contemporary cohorts, and for younger adult ages-at-diagnosis (Tables 2 and 3). These results show that all BMI values above average increase the risk of type 2 diabetes. Using age 13 and a diagnosis at 30-47 years as an example, all BMI values above-average (≥18.2 kg/m^2 for girls, ≥17.8 kg/m^2 for boys) were positively associated with type 2 diabetes (Figure 2). The estimates were stronger in women than men, and increased in magnitude for the later born cohorts (Figure 2). Similar patterns were observed for BMIs at ages 7 to 12 years, though the hazard ratios for type 2 diabetes were highest at 13 years (Tables 2 and 3, Tables S2 and S3).

Birth weights were available for 222 178 individuals, among whom there were 12 462 cases of type 2 diabetes. No interactions between birth weight and childhood BMI on type 2 diabetes at any age in women (all p-values >0.61) or men (all p-values >0.08) were detected. Low and high birth weights were significantly associated with type 2 diabetes after adjustment for childhood BMI (data not shown). Adjusting for birth weight had little influence on the associations between childhood BMIs and type 2 diabetes, which is illustrated for age 13 years (Figure 2, Tables S4 and S4).

The sensitivity analyses using the Danish Diabetes Register included 25 961 cases of type 2 diabetes (6941 more cases than the NPR-only definition), and they yielded findings similar to the NPR-only data though the associations for above-average BMIs were slightly weaker (Tables S6 and S7).

Using type 2 diabetes at 30-47 years as an example, PAF estimates rose from 11 to 40% among women and from 6 to 31% among men across the different birth cohorts, with the highest estimates from the most recently-born cohort (1966-1983). Using levels of 25% childhood overweight (similar to contemporary levels in Western Europe), the PAFs would be as high as 71% among women and 61% among men.

Discussion

In this large study with long-term follow-up, we found that below-average childhood BMIs were generally not associated with type 2 diabetes, whereas above-average BMIs were positively associated with type 2 diabetes in adult life. These associations were stronger in women than men, in younger compared with older generations, and at younger adult ages-at-diagnosis. Moreover, they were not affected by birth weight.

At the lower end of the BMI distribution, we found limited evidence for associations with type 2 diabetes. Inverse associations between BMI at some ages with type 2 diabetes were found in a subset of individuals who were born in the earliest years of the cohort (1930-1947) and diagnosed at the oldest ages (66-83 years) (Tables 2 and 3). This finding is similar to those from the British and Finnish studies, though the Finnish study only reported results adjusted for adult BMI.[7,8]

Above-average BMI values were consistently and positively associated with adult type 2 diabetes, the greater the BMI z-scores, the greater the risk. From the earliest through the most recent-born cohorts, a comparison between two 13 year-old-girls of average height of whom one weighed 6.4 to 6.9 kg more (equivalent to 2.7 BMI units or 1 z-score) showed that the hazard ratios for type 2 diabetes ranged from 2.12 to 2.84. Similarly, a comparison across the birth cohorts between two 13 year-old boys of average height of whom one weighed 5.5 to 6.0 kg more (equivalent to 2.5 BMI units or 1 z-score) showed the hazard ratios ranged from 1.84 to 2.49 for type 2 diabetes. Thus in all birth years from 1930 to 1989 an above-average BMI increased the risk of adult type 2 diabetes, and it seems that excess weight in children of more recent generations may be more hazardous than in earlier generations.

The strength of the risk estimates of adult type 2 diabetes increased with older childhood age at BMI measurement in both sexes. A similar upward trend with advancing age has been reported in the

1958 British birth cohort.[7] The most straight-forward explanation is that BMI at 13 years is more proximal in time to adult body size than BMI at 7 years; BMI at 13 years is a better marker of adult overweight than BMI at earlier ages, although correlations between child and mid-adulthood overweight are moderate in magnitude.[24] It has been suggested that weight gain in adult life is associated with an increased risk of type 2 diabetes beyond the effect of attained body weight.[25] Future studies with life-course BMI values are required to further disentangle the effects of changes in BMI from childhood through adulthood.

In this study, the associations between childhood BMI and type 2 diabetes were similar whether or not birth weight was accounted for, and there were no interactions. In contrast, a Finnish study found an interaction such that high birth weight and high BMI at age 12 years increased the risk of type 2 diabetes.[10] Differences in the analytic methods may explain the contrasting results as the Finnish study categorized both birth weight and BMI and investigated men and women together. We analyzed men and women separately. We previously showed that risk of type 2 diabetes is associated with low birth weight in women and men with stronger estimates in women than men, and with high birth weight in women only.[26] Our present findings suggest that low and high birth weight and high childhood BMI affect the risk of adult type 2 diabetes through different pathways.

Our findings of stronger associations between child BMI and adult type 2 diabetes in women than men are consistent with those from the previously mentioned Finnish study.[9] We can only speculate about potential reasons for these differences, but part of the explanation may be that girls have a larger percentage of total body fat for a given BMI than boys.[27] It has been suggested that associations between abdominal obesity and type 2 diabetes may be stronger among women than men and that alterations in glucocorticoids and sex hormones may contribute to the development of type 2 diabetes.[28] Moreover, early rather than late pubertal development in girls may play a role, for instance due to hormonal exposure or to associations between early menarche and later obesity, leading to an increased risk of type 2 diabetes.[29] Nonetheless, our results advance the growing evidence for a sex-dependent relationship between BMI and type 2 diabetes that apparently is acting all the way from birth,[26] now shown in childhood, as well as in adulthood.[15,16]

Throughout the study period there have been changes in the definition and assessment of diabetes. An increased focus on overweight individuals in recent years, leading to improved awareness and detection, may have added to the secular trend between a childhood BMI above average and adult type 2 diabetes. An alternate explanation is that a decreasing prevalence of other risk factors for type 2 diabetes, such as smoking[30,31] and hypertension[32,33], produced a time trend in the strength of the associations with BMI. Similar secular trends between BMI and hypertension were reported in a study of the 1946 and 1958 British birth cohorts,[34] suggesting that BMI has generally become a relatively more important risk factor.

A major advantage of our study is the up to 36 years of follow-up allowing us to investigate the effect of childhood BMI on type 2 diabetes in all ages from 30 to 83 years. Although the frequency of type 2 diabetes increased with age in both sexes, we found stronger associations of above-average childhood BMIs with type 2 diabetes among those diagnosed in early versus late adulthood. The finding may be explained by the shorter distance in time from the childhood BMI measures. It is biologically plausible that excess weight in childhood leads to type 2 diabetes through the early development of insulin resistance.[35,36] Since early-onset type 2 diabetes has a worse prognosis in terms of cardiovascular events and death[37] and since type 2 diabetes is also linked with other diseases such as cancer,[38] these results are of serious concern.

We studied a large ethnically homogeneous cohort of Caucasian children across a long follow-up period.[17] The health examinations were conducted at public and private schools, which eliminates selection bias due to associations between socioeconomic factors and BMI in childhood. In

Denmark, health care has been and still is provided free of charge, so socioeconomic bias in diagnosis is unlikely. Due to the register-based nature of the study, we lack information on those diagnosed by general practitioners and not seen in hospitals and those not diagnosed at all. The register does not provide information about how the diagnosis was made, and the recorded cases are likely more advanced clinical cases. The age at type 2 diabetes onset is, to an unknown degree, overestimated by the use of age at first hospital discharge with this diagnosis as a proxy for age at onset. However, the similar findings in the analyses using the National Diabetes Register, which also includes cases managed in the primary sector, supports the validity of our findings. Information on important determinants for type 2 diabetes such as family history of type 2 diabetes, adult body size and body composition, socioeconomic factors, or physical activity was not available. However, these factors may very well be mediators rather than confounders and it was not the aim to assess mediation through these factors.

The children in this study were relatively lean compared with contemporary European populations. Thus, our study shows that the risks of type 2 diabetes start to increase at BMI levels far below those considered as having associations with adverse health consequences. In combination with the current high levels of child overweight,[3] the increasing relative risks of type 2 diabetes by greater BMI in the younger birth cohorts and for early adult type 2 diabetes, suggests that many children of today face a potentially serious health threat of developing type 2 diabetes in adulthood. To illustrate our results in relation to contemporary levels of childhood overweight and obesity, PAF estimates showed that up to 71% of adult type 2 diabetes cases could be avoided if childhood overweight and obesity at 13 years of age were eliminated. These estimates should be interpreted cautiously as they assume an unverifiable causal association. Nonetheless, they suggest that the public health significance of a high childhood BMI may be substantial. Since the associations with type 2 diabetes were stronger at age 13 than 7 years, our results suggest there is potential for intervention during school years to reduce the burden of adult type 2 diabetes.

In conclusion, this study shows that childhood BMIs below average are generally unrelated to diabetes whereas having a childhood BMI above average increases the risk of adult type 2 diabetes linearly, and more so in women than in men. The associations are not affected by birth weight. Further, contemporary children have higher risk estimates than those from previous generations and the magnitude of the associations decreases the older the adult age-at-diagnosis. Since contemporary children are heavier than their counterparts from previous generations, our findings underscore the increasing deleterious effects of excess childhood weight, and suggest that large numbers of children may be at risk of developing type 2 diabetes in early adulthood. This adds to the justification for efforts aimed at reducing levels of childhood overweight and obesity by prevention and treatment as well as targeted screenings for pre-diabetes in this group to avoid transitioning to diabetes.

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Figure legends

Figure 1 Association between BMI z-scores at age 13 years and type 2 diabetes diagnosed at ages 30-47 years in women and men. The x-axis is truncated to depict the inner 95% of the distribution. The hazard ratios are estimated by Cox regressions, and the associations are stratified by year of birth in 1-year intervals. The confidence intervals are depicted as the minimum and maximum values from the sets of sex-specific birth cohort analyses.

Figure 2 Association between BMI z-scores at age 13 years and type 2 diabetes diagnosed at ages 30-47 years in women and men born 1948-1965, unadjusted and adjusted for birth weight. The x-axis is truncated to depict the inner 95% of the distribution. The hazard ratios are estimated by Cox regressions, and the associations are stratified by year of birth in 1-year intervals. The confidence intervals are depicted as the minimum and maximum values from the sets of sex-specific birth cohort analyses.

Table 1. Characteristics of the study population

		Women			Men		
			BMI z-score[a]			BMI z-score[a]	
		BMI (kg/m^2)[b]	<0	>0	BMI (kg/m^2)[b]	<0	>0
Age (years)	**Birth cohort**	**Mean ± SD**	**No. (cases)**	**No. (cases)**	**Mean ± SD**	**No. (cases)**	**No. (cases)**
7	**1930-1947**	15.3 ± 1.3	31 206 (2580)	26 967 (2432)	15.5 ± 1.1	29 674 (4030)	27 366 (3836)
	1948-1965	15.3 ± 1.4	25 343 (845)	20 461 (946)	15.4 ± 1.2	24 692 (1370)	20 853 (1381)
	1966-1983	15.7 ± 1.6	11 472 (57)	13 613 (108)	15.8 ± 1.4	11217 (79)	14 517 (142)
10	**1930-1947**	16.6 ± 1.7	31 052 (2384)	28 559 (2744)	16.6 ± 1.5	31 219 (3924)	26 803 (4049)
	1948-1965	16.6 ± 1.9	25 185 (729)	21 478 (1097)	16.6 ± 1.7	25 586 (1222)	20 723 (1599)
	1966-1983	17.0 ± 2.3	8978 (37)	9889 (113)	17.0 ± 2.1	8961 (55)	9963 (146)
13	**1930-1947**	18.6 ± 2.2	28 828 (1990)	30 524 (3100)	18.0 ± 1.9	29 561 (3479)	27 238 (4320)
	1948-1965	18.5 ± 2.5	23 474 (627)	23 090 (1195)	18.1 ± 2.2	24 324 (1038)	21 736 (1765)
	1966-1983	19.1 ± 2.9	6648 (26)	8916 (112)	18.6 ± 2.7	7098 (49)	8582 (142)

[a] Based upon the internal reference, in girls a z-score of 0= 15.3 kg/m^2 at age 7 years, 16.4 kg/m^2 at age 10 years and 18.2 kg/m^2 at age 13 years. In boys, a z-score of 0= 15.4 kg/m^2 at age 7 years, 16 .5 kg/m^2 at age 10 years and 17.8 kg/m^2 at age 13 years.

[b] P-values for trend from a linear regression analysis of BMI on birth cohort were <0.001 for BMIs at ages 7, 10 and 13 years.

Table 2. Associations between childhood BMI and adult type 2 diabetes in women by year of birth and age-at-diagnosis

		Birth years					
		1930-1947			1948-1965		1966-1983
		Age-at-diagnosis (years)			Age-at-diagnosis (years)		Age-at-diagnosis (years)
	Age (years)	30-47	48-65	66-83	30-47	48-65	30-47
BMI z-scores <0: effect per z-score decrease	7	0.99 (0.86-1.15)	1.14 (1.06-1.23)	1.20 (1.10-1.30)	0.91 (0.79-1.05)	1.05 (0.95-1.16)	1.10 (0.77-1.56)
	10	0.99 (0.84-1.16)	1.01 (0.92-1.11)	1.17 (1.06-1.28)	0.94 (0.80-1.10)	0.96 (0.86-1.08)	0.86 (0.54-1.37)
	13	1.00 (0.84-1.19)	0.93 (0.85-1.02)	1.07 (0.97-1.18)	0.93 (0.79-1.09)	0.86 (0.76-0.98)	0.91 (0.55-1.51)
BMI z-scores >0: effect per z-score increase	7	1.65 (1.47-1.85)	1.47 (1.37-1.57)	1.24 (1.13-1.36)	1.69 (1.52-1.88)	1.51 (1.38-1.64)	2.30 (1.93-2.74)
	10	1.99 (1.78-2.22)	1.63 (1.52-1.75)	1.38 (1.26-1.52)	2.12 (1.91-2.35)	1.74 (1.60-1.89)	2.68 (2.18-3.31)
	13	2.12 (1.91-2.36)	1.76 (1.65-1.88)	1.43 (1.32-1.57)	2.31 (2.09-2.54)	1.91 (1.77-2.07)	2.84 (2.31-3.49)

The hazard ratios illustrate the relative risk per 1-unit BMI z-score away from zero. E.g. a HR of 1.10 (CI 0.77-1.56) in 7 year old girls with a BMI z-score below average (in the 1966-1983 birth cohort, with age-at-diagnosis between 30-47 years) means that the relative risk of adult type 2 diabetes increases by 10% per 1-unit *lower* BMI z-score below zero. A HR of 2.30 (CI 1.93-2.74) in 7 year old girls with a BMI z-score above average means that the risk of adult type 2 diabetes increases by 130% per 1-unit *higher* BMI z-score above zero.

Table 3. Associations between childhood BMI and adult type 2 diabetes in men by year of birth and age-at-diagnosis

		Birth years					
		1930-1947			1948-1965		1966-1983
		Age-at-diagnosis (years)			Age-at-diagnosis (years)		Age-at-diagnosis (years)
	Age (years)	**30-47**	**48-65**	**66-83**	**30-47**	**48-65**	**30-47**
BMI z-scores <0: effect per z-score decrease	7	1.00 (0.88-1.11)	1.05 (0.99-1.11)	1.08 (1.00-1.16)	1.05 (0.94-1.16)	1.10 (1.02-1.19)	1.32 (1.02-1.71)
	10	0.99 (0.88-1.11)	1.02 (0.96-1.09)	1.04 (0.96-1.13)	0.97 (0.87-1.09)	1.00 (0.92-1.09)	1.05 (0.76-1.45)
	13	0.90 (0.79-1.03)	0.97 (0.90-1.04)	1.02 (0.94-1.11)	0.87 (0.77-0.99)	0.93 (0.85-1.03)	1.04 (0.72-1.50)
BMI z-scores >0: effect per z-score increase	7	1.38 (1.25-1.52)	1.18 (1.11-1.25)	1.11 (1.01-1.21)	1.63 (1.50-1.79)	1.39 (1.29-1.50)	2.08 (1.76-2.45)
	10	1.70 (1.55-1.86)	1.41 (1.33-1.49)	1.17 (1.07-1.28)	1.92 (1.77-2.09)	1.60 (1.49-1.71)	2.36 (1.96-2.84)
	13	1.84 (1.69-2.01)	1.58 (1.50-1.67)	1.37 (1.26-1.49)	2.07 (1.91-2.25)	1.78 (1.67-1.90)	2.49 (2.07-3.01)

The hazard ratios illustrate the risk associated with each 1-unit higher in BMI z-score before and after zero. E.g. a HR of 1.32 (CI 1 .02-1.71) in 7 year old boys with a BMI z-score below the average (in the 1966-1983 birth cohort with age-at-diagnosis between 30-47 years) means that the risk of adult type 2 diabetes increases by 32% per 1-unit *lower* BMI z-score below zero. A HR of 2.08 (CI 1.76-2.45) in 7 year old boys with a BMI z-score above average means that the risk of adult type 2 diabetes increases by 108% per 1-unit *higher* BMI z-score above zero.

Figure 1

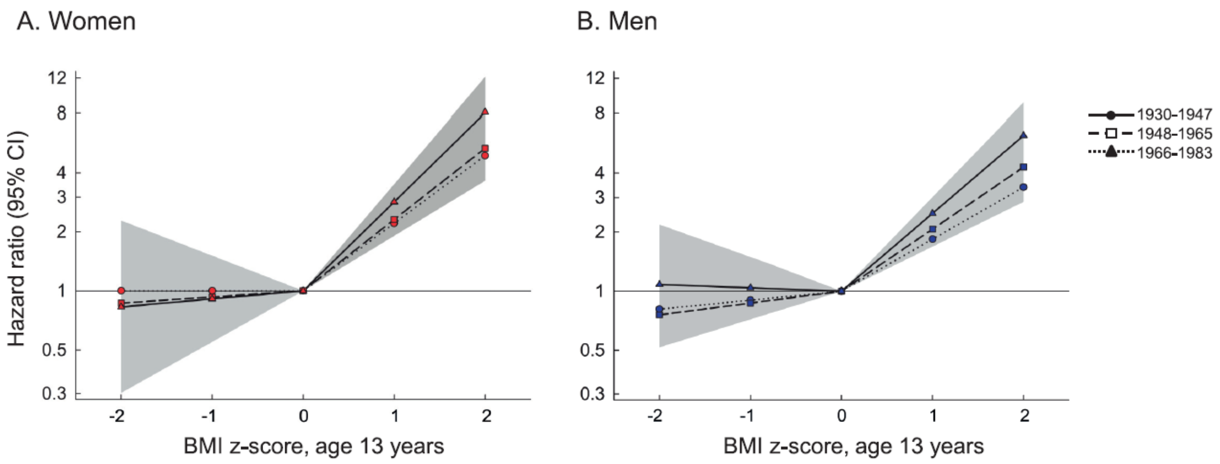
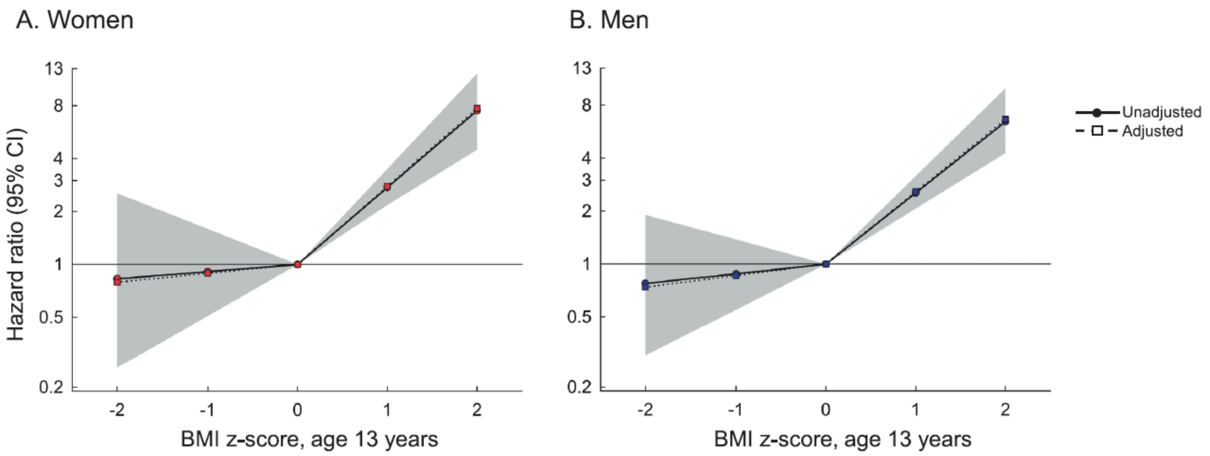


Figure 2



Electronic Supplementary Material for:

Childhood body mass index and development of type 2 diabetes throughout adult life – a large-scale Danish cohort study

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Table S1. Characteristics of the study population at birth

Table S2. Associations between childhood BMI and adult type 2 diabetes in women by year of birth and age-at-diagnosis at ages 7 through 13 years

Table S3. Associations between childhood BMI and adult type 2 diabetes in men by year of birth and age-at-diagnosis at ages 7 through 13 years

Table S4. Associations between childhood BMI and adult type 2 diabetes in women by year of birth and age-at-diagnosis, unadjusted and adjusted for birth weight

Table S5. Associations between childhood BMI and adult type 2 diabetes in men by year of birth and age-at-diagnosis, unadjusted and adjusted for birth weight

Table S6. Associations between childhood BMI and adult type 2 diabetes in women by year of birth and age-at-diagnosis using the National Diabetes Register

Table S7. Associations between childhood BMI and adult type 2 diabetes in men by year of birth and age-at-diagnosis using the National Diabetes Register

Figure S1. Flow chart of eligible individuals and those included in the study

Figure S2. Flow chart of eligible individuals and those included in the study using birth weight data

Figure S3. Frequency of adult type 2 diabetes per 1000 person years by sex and age-at-diagnosis

Table S1. Characteristics of the study population at birth

	Women	Men
	Birth weight (kg)	**Birth weight (kg)**
Birth cohort	**Mean ± SD**	**Mean ± SD**
1930-1947	3.32 ± 0.56	3.45 ± 0.58
1948-1965	3.27 ± 0.55	3.39 ± 0.58
1966-1983	3.27 ± 0.52	3.39 ± 0.56

Table S2. Associations between childhood BMI and adult type 2 diabetes in women by year of birth and age-at-diagnosis at ages 7 through 13 years

		Birth years					
		1930-1947			1948-1965		1966-1983
		Age-at-diagnosis (years)			Age-at-diagnosis (years)		Age-at-diagnosis (years)
BMI z-score	**Age (years)**	**30-47**	**48-65**	**66-83**	**30-47**	**48-65**	**30-47**
BMI z-scores <0: effect per z-score decrease	7	0.99 (0.86-1.15)	1.14 (1.06-1.23)	1.20 (1.10-1.30)	0.91 (0.79-1.05)	1.05 (0.95-1.16)	1.10 (0.77-1.56)
	8	0.97 (0.83-1.14)	1.07 (0.98-1.17)	1.18 (1.08-1.29)	0.93 (0.80-1.07)	1.02 (0.92-1.13)	1.13 (0.80-1.60)
	9	0.99 (0.84-1.17)	1.06 (0.97-1.15)	1.21 (1.10-1.32)	0.92 (0.79-1.08)	0.98 (0.88-1.10)	1.06 (0.72-1.54)
	10	0.99 (0.84-1.16)	1.01 (0.92-1.11)	1.17 (1.06-1.28)	0.94 (0.80-1.10)	0.96 (0.86-1.08)	0.86 (0.54-1.37)
	11	0.98 (0.83-1.16)	0.99 (0.90-1.09)	1.17 (1.06-1.28)	0.92 (0.78-1.08)	0.93 (0.82-1.04)	0.76 (0.46-1.25)
	12	0.96 (0.81-1.14)	0.97 (0.88-1.06)	1.08 (0.98-1.19)	0.91 (0.78-1.07)	0.92 (0.81-1.04)	0.70 (0.41-1.19)
	13	1.00 (0.84-1.19)	0.93 (0.85-1.02)	1.07 (0.97-1.18)	0.93 (0.79-1.09)	0.86 (0.76-0.98)	0.91 (0.55-1.51)
BMI z-scores >0: effect per z-score increase	7	1.65 (1.47-1.85)	1.47 (1.37-1.57)	1.24 (1.13-1.36)	1.69 (1.52-1.88)	1.51 (1.38-1.64)	2.30 (1.93-2.74)
	8	1.71 (1.53-1.92)	1.52 (1.42-1.63)	1.31 (1.19-1.43)	1.77 (1.60-1.96)	1.57 (1.44-1.77)	2.56 (2.14-3.06)
	9	1.88 (1.68-2.10)	1.61 (1.50-1.72)	1.38 (1.26-1.51)	1.93 (1.74-2.14)	1.66 (1.52-1.80)	2.63 (2.17-3.19)
	10	1.99 (1.78-2.22)	1.63 (1.52-1.75)	1.38 (1.26-1.52)	2.12 (1.91-2.35)	1.74 (1.60-1.89)	2.68 (2.18-3.31)
	11	2.02 (1.80-2.26)	1.69 (1.58-1.82)	1.45 (1.32-1.59)	2.18 (1.96-2.42)	1.83 (1.68-1.98)	2.66 (2.15-3.29)
	12	2.06 (1.84-2.30)	1.75 (1.64-1.88)	1.41 (1.28-1.54)	2.24 (2.03-2.48)	1.91 (1.76-2.08)	2.68 (2.17-3.29)
	13	2.12 (1.91-2.36)	1.76 (1.65-1.88)	1.43 (1.32-1.57)	2.31 (2.09-2.54)	1.91 (1.77-2.07)	2.84 (2.31-3.49)

The hazard ratios illustrate the relative risk per 1-unit BMI z-score away from zero. E.g. a HR of 1.10 (CI 0.77-1.56) in 7 year old girls with a BMI z-score below average (in the 1966-1983 birth cohort, with age-at-diagnosis between 30-47 years) means that the relative risk of adult type 2 diabetes increases by 10% per 1-unit *lower* BMI z-score below zero. A HR of 2.30 (CI 1.93-2.74) in 7 year old girls with a BMI z-score above average means that the risk of adult type 2 diabetes increases by 130% per 1-unit *higher* BMI z-score above zero.

Table S3. Associations between childhood BMI and adult type 2 diabetes in men by year of birth and age-at-diagnosis at ages 7 through 13 years

		Birth years					
		1930-1947			1948-1965		1966-1983
		Age-at-diagnosis (years)			Age-at-diagnosis (years)		Age-at-diagnosis (years)
BMI z-score	**Age (years)**	**30-47**	**48-65**	**66-83**	**30-47**	**48-65**	**30-47**
BMI z-scores <0: effect per z-score decrease	7	1.00 (0.88-1.11)	1.05 (0.99-1.11)	1.08 (1.00-1.16)	1.05 (0.94-1.16)	1.10 (1.02-1.19)	1.32 (1.02-1.71)
	8	0.94 (0.84-1.06)	1.06 (0.99-1.12)	1.08 (1.00-1.17)	0.98 (0.88-1.09)	1.10 (1.01-1.19)	1.22 (0.94-1.59)
	9	0.94 (0.84-1.06)	1.04 (0.98-1.11)	1.07 (0.99-1.16)	0.97 (0.87-1.09)	1.07 (0.99-1.16)	1.17 (0.88-1.57)
	10	0.99 (0.88-1.11)	1.02 (0.96-1.09)	1.04 (0.96-1.13)	0.97 (0.87-1.09)	1.00 (0.92-1.09)	1.05 (0.76-1.45)
	11	0.95 (0.84-1.08)	0.99 (0.93-1.06)	0.98 (0.90-1.06)	0.92 (0.82-1.04)	0.96 (0.88-1.05)	0.99 (0.70-1.40)
	12	0.91 (0.80-1.03)	0.99 (0.92-1.06)	1.00 (0.92-1.09)	0.87 (0.77-0.98)	0.94 (0.86-1.03)	1.05 (0.75-1.46)
	13	0.90 (0.79-1.03)	0.97 (0.90-1.04)	1.02 (0.94-1.11)	0.87 (0.77-0.99)	0.93 (0.85-1.03)	1.04 (0.72-1.50)
BMI z-scores >0: effect per z-score increase	7	1.38 (1.25-1.52)	1.18 (1.11-1.25)	1.11 (1.01-1.21)	1.63 (1.50-1.79)	1.39 (1.29-1.50)	2.08 (1.76-2.45)
	8	1.43 (1.30-1.58)	1.25 (1.18-1.33)	1.13 (1.03-1.24)	1.65 (1.52-1.81)	1.45 (1.35-1.55)	2.20 (1.86-2.60)
	9	1.59 (1.45-1.74)	1.34 (1.26-1.42)	1.14 (1.04-1.25)	1.81 (1.66-1.97)	1.52 (1.42-1.64)	2.36 (1.98-2.82)
	10	1.70 (1.55-1.86)	1.41 (1.33-1.49)	1.17 (1.07-1.28)	1.92 (1.77-2.09)	1.60 (1.49-1.71)	2.36 (1.96-2.84)
	11	1.78 (1.63-1.96)	1.47 (1.39-1.56)	1.22 (1.11-1.33)	2.03 (1.87-2.21)	1.67 (1.56-1.79)	2.39 (1.96-2.92)
	12	1.80 (1.64-1.97)	1.54 (1.46-1.63)	1.31 (1.20-1.42)	2.02 (1.86-2.20)	1.74 (1.62-1.86)	2.32 (1.92-2.83)
	13	1.84 (1.69-2.01)	1.58 (1.50-1.67)	1.37 (1.26-1.49)	2.07 (1.91-2.25)	1.78 (1.67-1.90)	2.49 (2.07-3.01)

The hazard ratios illustrate the risk associated with each 1-unit higher in BMI z-score before and after zero. E.g. a HR of 1.32 (CI 1 .02-1.71) in 7 year old boys with a BMI z-score below the average (in the 1966-1983 birth cohort with age-at-diagnosis between 30-47 years) means that the risk of adult type 2 diabetes increases by 32% per 1-unit *lower* BMI z-score below zero. A HR of 2.08 (CI 1.76-2.45) in 7 year old boys with a BMI z-score above average means that the risk of adult type 2 diabetes increases by 108% per 1-unit *higher* BMI z-score above zero.

Table S4. Associations between childhood BMI and adult type 2 diabetes in women by year of birth and age-at-diagnosis, unadjusted and adjusted for birth weight

		Birth years							
		1930-1947				1948-1965			1966-1983
		Age-at-diagnosis (years)							
BMI z-score	**Age (years)**	**30-47**	**48-65**	**66-83**		**30-47**	**48-65**		**30-47**
BMI z-scores <0: effect per z-score decrease	7	1.02 (0.86-1.21)	1.08 (0.98-1.19)	1.14 (1.00-1.31)		0.97 (0.83-1.13)	1.03 (0.92-1.15)		1.14 (0.78-1.66)
	7[a]	0.98 (0.82-1.16)	1.04 (0.96-1.15)	1.10 (0.96-1.27)		0.93 (0.80-1.09)	0.99 (0.89-1.11)		1.09 (0.75-1.59)
	8	0.97 (0.81-1.17)	1.03 (0.93-1.15)	1.16 (1.00-1.34)		0.95 (0.81-1.12)	1.01 (0.90-1.13)		1.19 (0.82-1.73)
	8[a]	0.93 (0.78-1.12)	0.99 (0.89-1.10)	1.11 (0.96-1.29)		0.91 (0.77-1.07)	0.97 (0.86-1.09)		1.15 (0.79-1.67)
	9	0.99 (0.82-1.19)	1.02 (0.92-1.14)	1.16 (0.99-1.34)		0.93 (0.79-1.11)	0.97 (0.86-1.09)		1.10 (0.73-1.67)
	9[a]	0.95 (0.78-1.14)	0.98 (0.88-1.10)	1.11 (0.95-1.29)		0.90 (0.75-1.06)	0.93 (0.82-1.05)		1.06 (0.70-1.61)
	10	1.00 (0.83-1.21)	0.99 (0.88-1.11)	1.13 (0.97-1.32)		0.94 (0.79-1.12)	0.93 (0.82-1.06)		0.79 (0.46-1.34)
	10[a]	0.96 (0.79-1.17)	0.95 (0.85-1.06)	1.09 (0.93-1.27)		0.91 (0.77-1.08)	0.90 (0.79-1.02)		0.77 (0.45-1.30)
	11	1.03 (0.85-1.25)	0.99 (0.89-1.11)	1.12 (0.96-1.31)		0.93 (0.78-1.11)	0.90 (0.79-1.02)		0.76 (0.44-1.32)
	11[a]	0.99 (0.82-1.20)	0.96 (0.86-1.07)	1.08 (0.92-1.26)		0.90 (0.76-1.08)	0.87 (0.77-0.99)		0.74 (0.42-1.28)
	12	1.05 (0.87-1.28)	0.98 (0.87-1.10)	1.05 (0.90-1.23)		0.95 (0.79-1.13)	0.88 (0.77-1.01)		0.70 (0.39-1.26)
	12[a]	1.02 (0.84-1.24)	0.95 (0.85-1.06)	1.02 (0.87-1.19)		0.92 (0.77-1.10)	0.86 (0.75-0.98)		0.68 (0.38-1.23)
	13	1.10 (0.91-1.34)	0.92 (0.82-1.04)	1.06 (0.90-1.24)		1.01 (0.85-1.21)	0.85 (0.74-0.98)		0.91 (0.52-1.59)
	13[a]	1.07 (0.88-1.30)	0.90 (0.80-1.01)	1.03 (0.88-1.20)		0.99 (0.83-1.18)	0.83 (0.73-0.95)		0.89 (0.51-1.56)
BMI z-scores >0: effect per z-score increase	7	1.77 (1.56-2.01)	1.47 (1.35-1.59)	1.25 (1.09-1.44)		1.82 (1.62-2.03)	1.51 (1.38-1.65)		2.19 (1.80-2.66)
	7[a]	1.79 (1.58-2.03)	1.49 (1.38-1.62)	1.27 (1.11-1.46)		1.84 (1.64-2.05)	1.53 (1.40-1.68)		2.21 (1.81-2.69)
	8	1.80 (1.59-2.04)	1.54 (1.42-1.67)	1.34 (1.17-1.53)		1.84 (1.65-2.06)	1.58 (1.44-1.73)		2.51 (2.05-3.06)
	8[a]	1.83 (1.61-3.07)	1.57 (1.44-1.70)	1.36 (1.19-1.55)		1.87 (1.67-2.09)	1.60 (1.46-1.75)		2.53 (2.07-3.08)
	9	1.96 (1.73-2.22)	1.62 (1.49-1.76)	1.38 (1.21-1.58)		2.00 (1.79-2.24)	1.66 (1.52-1.81)		2.55 (2.05-3.18)
	9[a]	1.99 (1.75-2.25)	1.64 (1.52-1.78)	1.41 (1.23-1.61)		2.02 (1.81-2.26)	1.67 (1.53-1.83)		2.58 (2.08-3.22)
	10	2.08 (1.83-2.36)	1.67 (1.54-1.81)	1.40 (1.22-1.60)		2.18 (1.95-2.44)	1.75 (1.60-1.91)		2.48 (1.96-3.14)
	10[a]	2.10 (1.85-2.39)	1.69 (1.56-1.83)	1.42 (1.24-1.63)		2.20 (1.96-2.46)	1.76 (1.61-1.93)		2.51 (1.98-3.18)
	11	2.14 (1.88-2.43)	1.75 (1.61-1.90)	1.44 (1.26-1.65)		2.23 (1.99-2.50)	1.82 (1.67-1.99)		2.51 (1.96-3.21)
	11[a]	2.16 (1.90-2.46)	1.77 (1.63-1.92)	1.46 (1.28-1.68)		2.25 (2.01-2.52)	1.84 (1.68-2.01)		2.54 (1.99-3.25)
	12	2.21 (1.95-2.50)	1.79 (1.65-1.94)	1.42 (1.24-1.62)		2.34 (2.09-2.61)	1.90 (1.74-2.07)		2.52 (1.99-3.20)
	12[a]	2.24 (1.97-2.53)	1.81 (1.67-1.96)	1.43 (1.25-1.64)		2.36 (2.11-2.63)	1.91 (1.75-2.08)		2.55 (2.01-3.24)
	13	2.28 (2.02-2.57)	1.78 (1.65-1.93)	1.48 (1.30-1.68)		2.45 (2.20-2.72)	1.92 (1.76-2.09)		2.74 (2.18-3.44)
	13[a]	2.31 (2.04-2.60)	1.81 (1.67-1.95)	1.50 (1.32-1.70)		2.47 (2.22-2.74)	1.93 (1.78-2.11)		2.78 (2.21-3.49)

[a] Adjusted for birth weight

The hazard ratios illustrate the relative risk per 1-unit BMI z-score away from zero. E.g. a HR of 1.14 (0.78-1.66) in 7 year old girls with a BMI z-score below average (in the 1966-1983 birth cohort, with age-at-diagnosis between 30-47 years) means that the relative risk of adult type 2 diabetes increases by 14% per 1-unit *lower* BMI z-score below zero. A HR of 2.19 (1.80-2.66) in 7 year old girls with a BMI z-score above average means that the risk of adult type 2 diabetes increases by 119% per 1-unit *higher* BMI z-score above zero.

Table S5. Associations between childhood BMI and adult type 2 diabetes in men by year of birth and age-at-diagnosis, unadjusted and adjusted for birth weight

		Birth years							
		1930-1947			1948-1965			1966-1983	
		Age-at-diagnosis (years)							
BMI z-score	**Age (years)**	**30-47**	**48-65**	**66-83**		**30-47**	**48-65**		**30-47**
BMI z-scores <0: effect per z-score decrease	7	0.93 (0.82-1.05)	1.01 (0.94-1.08)	1.07 (0.95-1.21)		1.02 (0.91-1.14)	1.11 (1.02-1.20)		1.29 (0.97-1.70)
	7[a]	0.90 (0.79-1.02)	0.98 (0.86-1.17)	1.04 (0.92-1.17)		0.99 (0.88-1.11)	1.08 (0.99-1.17)		1.26 (0.95-1.66)
	8	0.95 (0.83-1.08)	1.05 (0.97-1.13)	1.07 (0.94-1.21)		0.98 (0.87-1.11)	1.09 (1.00-1.18)		1.21 (0.91-1.62)
	8[a]	0.91 (0.80-1.05)	1.01 (0.94-1.09)	1.03 (0.91-1.17)		0.95 (0.84-1.07)	1.05 (0.96-1.15)		1.18 (0.88-1.57)
	9	0.97 (0.85-1.11)	1.04 (0.96-1.12)	1.06 (0.94-1.20)		0.99 (0.87-1.12)	1.06 (0.97-1.16)		1.20 (0.87-1.64)
	9[a]	0.94 (0.82-1.07)	1.00 (0.93-1.08)	1.02 (0.90-1.16)		0.96 (0.84-1.08)	1.02 (0.93-1.12)		1.16 (0.85-1.59)
	10	0.98 (0.86-1.13)	1.01 (0.93-1.09)	1.02 (0.90-1.16)		0.97 (0.85-1.10)	0.99 (0.90-0.67)		1.03 (0.71-1.48)
	10[a]	0.95 (0.82-1.09)	0.97 (0.90-1.05)	0.98 (0.87-1.11)		0.93 (0.82-1.06)	0.96 (0.87-1.05)		1.00 (0.69-1.44)
	11	0.95 (0.83-1.10)	1.01 (0.93-1.09)	0.93 (0.81-1.06)		0.90 (0.79-1.03)	0.95 (0.86-1.05)		0.87 (0.58-1.31)
	11[a]	0.92 (0.80-1.06)	0.97 (0.89-1.05)	0.89 (0.78-1.02)		0.87 (0.76-1.00)	0.92 (0.84-1.01)		0.85 (0.57-1.27)
	12	0.90 (0.78-1.04)	0.99 (0.91-1.08)	0.93 (0.81-1.06)		0.85 (0.74-0.98)	0.94 (0.85-1.04)		0.90 (0.60-1.34)
	12[a]	0.87 (0.75-1.01)	0.96 (0.88-1.04)	0.89 (0.78-1.02)		0.82 (0.72-0.95)	0.91 (0.82-1.00)		0.87 (0.58-1.30)
	13	0.92 (0.79-1.07)	0.99 (0.91-1.08)	0.97 (0.85-1.11)		0.87 (0.75-1.00)	0.93 (0.84-1.03)		0.88 (0.57-1.38)
	13[a]	0.89 (0.76-1.03)	0.96 (0.88-1.04)	0.93 (0.82-1.07)		0.84 (0.73-0.97)	0.91 (0.82-1.01)		0.86 (0.55-1.34)
BMI z-scores >0: effect per z-score increase	7	1.42 (1.27-1.58)	1.21 (1.13-1.30)	1.17 (1.04-1.33)		1.63 (1.48-1.79)	1.39 (1.29-1.51)		2.02 (1.69-2.41)
	7[a]	1.45 (1.30-1.61)	1.24 (1.16-1.33)	1.20 (1.06-1.36)		1.65 (1.50-1.82)	1.42 (1.31-1.53)		2.05 (1.72-2.45)
	8	1.52 (1.37-1.69)	1.31 (1.22-1.40)	1.19 (1.05-1.35)		1.68 (1.53-1.85)	1.44 (1.33-1.55)		2.20 (1.84-2.63)
	8[a]	1.55 (1.40-1.73)	1.33 (1.25-1.43)	1.22 (1.08-1.38)		1.71 (1.55-1.87)	1.46 (1.36-1.58)		2.24 (1.87-2.67)
	9	1.68 (1.52-1.87)	1.39 (1.30-1.49)	1.18 (1.04-1.34)		1.84 (1.68-2.02)	1.52 (1.41-1.64)		2.41 (2.01-2.90)
	9[a]	1.71 (1.55-1.90)	1.42 (1.33-1.52)	1.21 (1.06-1.37)		1.87 (1.70-2.04)	1.55 (1.44-1.67)		2.44 (2.03-2.94)
	10	1.78 (1.61-1.98)	1.47 (1.38-1.57)	1.21 (1.06-1.37)		1.94 (1.77-2.12)	1.60 (1.48-1.72)		2.41 (1.98-2.94)
	10[a]	1.81 (1.64-2.00)	1.49 (1.40-1.60)	1.23 (1.08-1.40)		1.97 (1.80-2.15)	1.62 (1.51-1.75)		2.45 (2.01-2.98)
	11	1.86 (1.68-2.06)	1.54 (1.44-1.64)	1.25 (1.11-1.42)		2.02 (1.84-2.21)	1.67 (1.56-1.80)		2.38 (1.93-1.95)
	11[a]	1.89 (1.70-2.09)	1.57 (1.47-1.67)	1.27 (1.13-1.44)		2.05 (1.87-2.24)	1.70 (1.58-1.83)		2.41 (1.95-2.99)
	12	1.88 (1.69-2.08)	1.61 (1.51-1.72)	1.31 (1.16-1.48)		2.03 (1.85-2.22)	1.74 (1.62-1.87)		2.32 (1.88-2.87)
	12[a]	1.90 (1.72-2.11)	1.64 (1.53-1.75)	1.34 (1.18-1.51)		2.06 (1.88-2.25)	1.77 (1.64-1.90)		2.36 (1.90-2.91)
	13	1.92 (1.74-2.12)	1.65 (1.55-1.76)	1.38 (1.23-1.55)		2.09 (1.91-2.28)	1.80 (1.68-1.93)		2.54 (2.07-3.12)
	13[a]	1.95 (1.76-2.15)	1.68 (1.58-1.79)	1.40 (1.25-1.58)		2.12 (1.94-2.32)	1.83 (1.71-1.97)		2.58 (2.10-3.16)

[a] Adjusted for birth weight

The hazard ratios illustrate the risk associated with each 1-unit higher in BMI z-score before and after zero. E.g. a HR of 1.29 (0.97-1.70) in 7 year old boys with a BMI z-score below the average (in the 1966-1983 birth cohort with age-at-diagnosis between 30-47 years) means that the risk of adult type 2 diabetes increases by 29% per 1-unit *lower* BMI z-score below zero. A HR of 2.02 (1.69-2.41) in 7 year old boys with a BMI z-score above average means that the risk of adult type 2 diabetes increases by 102% per 1-unit *higher* BMI z-score above zero.

Table S6. Associations between childhood BMI and adult type 2 diabetes in women by year of birth and age-at-diagnosis using the National Diabetes Register

		Birth years						
		1930-1947			**1948-1965**			**1966-1983**
		Age-at-diagnosis (years)						
BMI z-score	**Age (years)**	**48-65**	**66-83**		**30-47**	**48-65**		**30-47**
BMI z-scores <0: effect per z-score decrease	7	1.16 (1.09-1.24)	1.09 (1.02-1.17)		0.89 (0.77-1.03)	1.06 (0.98-1.14)		1.14 (0.91-1.42)
	8	1.14 (1.06-1.21)	1.05 (0.98-1.13)		0.86 (0.74-1.00)	1.05 (0.96-1.14)		1.00 (0.79-1.28)
	9	1.14 (1.06-1.22)	1.08 (1.00-1.16)		0.91 (0.78-1.06)	1.00 (0.92-1.09)		0.95 (0.73-1.23)
	10	1.08 (1.01-1.16)	1.05 (0.97-1.14)		0.91 (0.78-1.06)	0.97 (0.88-1.06)		0.96 (0.73-1.28)
	11	1.11 (1.03-1.19)	1.03 (0.95-1.11)		0.89 (0.76-1.05)	0.93 (0.85-1.02)		0.82 (0.60-1.12)
	12	1.06 (0.98-1.14)	1.01 (0.93-1.09)		0.89 (0.76-1.04)	0.91 (0.83-1.00)		0.70 (0.49-1.00)
	13	1.02 (0.95-1.10)	1.00 (0.92-1.09)		0.89 (0.76-1.05)	0.92 (0.83-1.01)		0.84 (0.59-1.20)
BMI z-scores >0: effect per z-score increase	7	1.33 (1.25-1.41)	1.08 (0.99-1.17)		1.68 (1.51-1.86)	1.37 (1.28-1.48)		2.02 (1.77-2.31)
	8	1.38 (1.30-1.47)	1.06 (0.98-1.15)		1.73 (1.56-1.91)	1.43 (1.33-1.54)		2.16 (1.89-2.47)
	9	1.47 (1.38-1.56)	1.12 (1.03-1.21)		1.91 (1.72-2.11)	1.47 (1.37-1.58)		2.24 (1.94-2.59)
	10	1.50 (1.41-1.59)	1.12 (1.03-1.21)		2.05 (1.85-2.27)	1.53 (1.42-1.64)		2.36 (2.03-2. 74)
	11	1.58 (1.48-1.67)	1.16 (1.07-1.26)		2.17 (1.96-2.41)	1.60 (1.49-1.72)		2.36 (2.02-2.76)
	12	1.61 (1.52-1.71)	1.20 (1.11-1.30)		2.21 (2.00-2.44)	1.65 (1.54-1.77)		2.40 (2.06-2.80)
	13	1.60 (1.52-1.70)	1.23 (1.14-1.32)		2.23 (2.02-2.45)	1.69 (1.58-1.81)		2.53 (2.17-2.95)

The hazard ratios illustrate the relative risk per 1-unit BMI z-score away from zero. E.g. a HR of 1.14 (0.91-1.42) in 7 year old girls with a BMI z-score below average (in the 1966-1983 birth cohort, with age-at-diagnosis between 30-47 years) means that the relative risk of adult type 2 diabetes increases by 14% per 1-unit *lower* BMI z-score below zero. A HR of 2.02 (1.77-2.31) in 7 year old girls with a BMI z-score above average means that the risk of adult type 2 diabetes increases by 102% per 1-unit *higher* BMI z-score above zero.

Table S7. Associations between childhood BMI and adult type 2 diabetes in men by year of birth and age-at-diagnosis using the National Diabetes Register

		Birth years						
		1930-1947			1948-1965			1966-1983
		Age-at-diagnosis (years)						
BMI z-score	**BMI z-score**	**48-65**	**66-83**		**30-47**	**48-65**		**30-47**
BMI z-scores <0: effect per z-score decrease	**Age (years)**	1.04 (0.98-1.10)	1.13 (1.07-1.21)		1.08 (0.97-1.21)	1.05 (0.98-1.12)		1.20 (0.97-1.48)
	7	1.05 (0.99-1.11)	1.13 (1.05-1.20)		1.01 (0.90-1.14)	1.05 (0.98-1.12)		1.28 (1.05-1.56)
	8	1.06 (1.00-1.12)	1.10 (1.03-1.18)		0.97 (0.86-1.10)	1.02 (0.96-1.10)		1.33 (1.07-1.63)
	9	1.03 (0.97-1.09)	1.09 (1.01-1.16)		0.94 (0.82-1.06)	0.96 (0.90-1.04)		1.26 (1.01-1.58)
	10	1.02 (0.96-1.08)	1.05 (0.98-1.12)		0.84 (0.73-0.97)	0.95 (0.88-1.02)		1.11 (0.86-1.42)
	11	1.00 (0.94-1.06)	1.06 (0.99-1.14)		0.83 (0.72-0.96)	0.93 (0.86-1.00)		1.03 (0.79-1.34)
	12	0.98 (0.92-1.04)	1.07 (0.99-1.15)		0.85 (0.73-0.98)	0.93 (0.86-1.00)		1.00 (0.75-1.34)
BMI z-scores >0: effect per z-score increase	13	1.10 (1.05-1.17)	1.04 (0.97-1.13)		1.62 (1.47-1.79)	1.23 (1.15-1.32)		1.67 (1.43-1.94)
	7	1.18 (1.12-1.24)	1.05 (0.97-1.14)		1.67(1.52-1.84)	1.28 (1.20-1.37)		1.88 (1.62-2.18)
	8	1.27 (1.20-1.34)	1.03 (0.95-1.12)		1.83 (1.67-2.01)	1.35 (1.27-1.44)		2.04 (1.75-2.37)
	9	1.32 (1.25-1.39)	1.07 (0.98-1.16)		1.94 (1.78-2.13)	1.42 (1.34-1.52)		2.14 (1.84-2.50)
	10	1.38 (1.31-1.46)	1.13 (1.04-1.23)		2.02 (1.85-2.21)	1.50 (1.41-1.60)		2.21 (1.88-2.60)
	11	1.43 (1.36-1.51)	1.20 (1.11-1.30)		2.10 (1.92-2.30)	1.54 (1.45-1.64)		2.11 (1.79-2.48)
	12	1.46 (1.39-1.54)	1.22 (1.13-1.32)		2.17 (1.99-2.37)	1.57 (1.48-1.66)		2.21 (1.88-2.59)

The hazard ratios illustrate the risk associated with each 1-unit higher in BMI z-score before and after zero. E.g. a HR of 1.20 (0.97-1.48) in 7 year old boys with a BMI z-score below the average (in the 1966-1983 birth cohort with age-at-diagnosis between 30-47 years) means that the risk of adult type 2 diabetes increases by 20% per 1-unit *lower* BMI z-score below zero. A HR of 1.67 (1.43-1.94) in 7 year old boys with a BMI z-score above average means that the risk of adult type 2 diabetes increases by 67% per 1-unit *higher* BMI z-score above zero.

Figure S1. Flow chart of eligible individuals and those included in the study

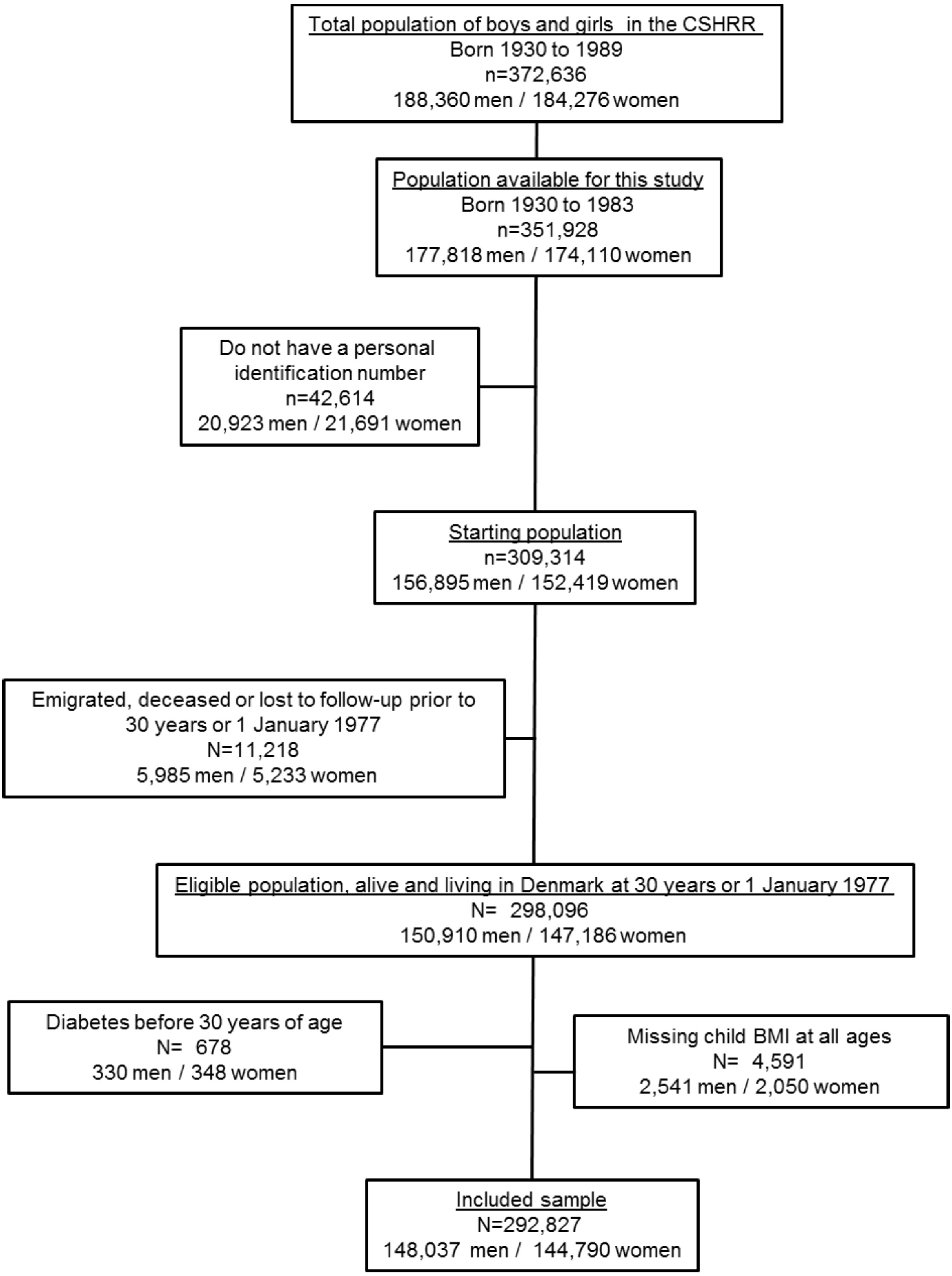

Figure S2. Flow chart of eligible individuals and those included in the study using birth weight data

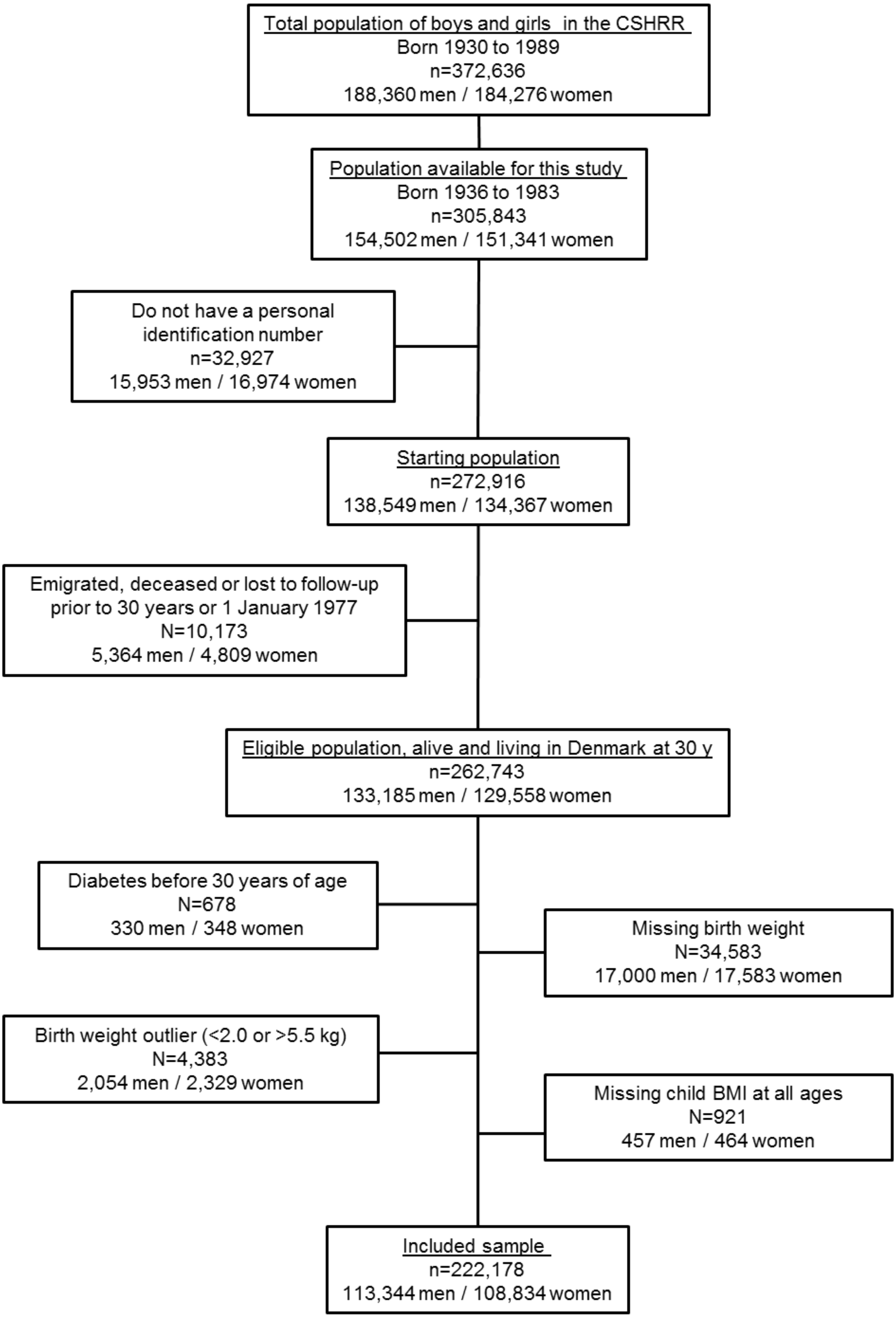

Figure S3. Frequency of adult type 2 diabetes per 1000 person years by sex and age-at-diagnosis