LS Working Paper 74

Patterns and determinants of birth weight in consecutive live births: results from the OPCS Longitudinal Study 1980-88

Susan Macran

David A Leon

June 1995

Social Statistics Research Unit
The City University
Northampton Square
London
EC1V OHB

Patterns and determinants of birth weight in consecutive live births: results from the OPCS Longitudinal Study 1980-88

Susan Macran*

David A Leon**

June 1995

* Social Statistics Research Unit
The City University
Northampton Square
London
EC1V OHB

Author for correspondence:

** Department of Epidemiology and Population Sciences
London School of Hygiene and Tropical Medicine
Keppel Street
London WC1E 7HT

ACKNOWLEDGEMENTS

This study is part of an ESRC funded programme, *Health Inequalities Among Women and Their Families* (R000232797), undertaken at the Centre for Population Studies, London School of Hygiene and Tropical Medicine. The permission of OPCS to use the Longtiudinal Study is gratefully acknowledged.

Patterns and determinants of birth weight in consecutive live births : results from the OPCS Longitudinal Study 1980-88

Summary

The weights of consecutive live singleton births occurring 1980-88 among 10,085 women born in 1950 or later were analysed. These women were a part of a one percent sample of all persons enumerated at the 1971 Census of England and Wales. A strong tendency to repeat birth weight was observed. The risk of a woman having a second birth that weighed less than 2500 grammes was 16.7 times greater (95% CI 8.2-34.2) among women whose first birth weighed less than 2500 grammes compared to women whose first birth weighed 4000 grammes or more. A regression to the mean effect was also observed, such that women whose first birth weighed 4000 grammes or more, had a second birth that was on average 426 grammes lighter, while women whose first birth weighed less than 2500 grammes had a second birth that was on average 918 grammes heavier. Both the tendency to repeat birth weight and the regression to the mean effect were observed in sets of first and second births that were of the same sex and in sets where the social class of the father recorded at birth registration was the same. These effect are consistent with previous findings, although this is the first time they have been studied in a large representative sample of the population of England and Wales. Evidence from other studies suggests that the tendency to repeat is the result of several mechanisms, of which continuity in circumstance between pregnancies and foetal genotype are likely to play only a minor role. The principle determinants involve factors that pass through the maternal line to constrain foetal growth in the latter part of pregnancy, although these may also be complemented by nutritional and other factors operating during a mother's own childhood.

Background

Comparatively little attention has been given to the study of the weight of consecutive births to the same mother. Since the early 1950s studies of this subject have been reported based on data from hospital populations in London [1,2], Oxford [3], Aberdeen [4-6] and the United States [7,8]. A sample of births to survivors of Hiroshima and Nagasaki [9] has also been studied, as have consecutive births occurring in the national population of Norway since the mid-1960s [10-13]. These studies have all shown a tendency to repeat birth weights.

The OPCS Longitudinal Study was initiated as a one per cent sample of the 1971 Census of England and Wales, to which vital events such as births, deaths and cancer registrations are linked [14]. This study provided for the first time the opportunity to examine whether the tendency to repeat birth weights seen in earlier studies was apparent in a large representative sample of recent consecutive births in England and Wales. The analyses also provided the opportunity to investigate the 'regression to the mean effect' between first and second births that has not previously be examined in detail.

Data and Methods

The OPCS Longitudinal Study (LS) involves the linkage of census records to records of vital events including birth and death registrations, for a one percent sample of the population of England and Wales [14,15]. All individuals born on one of four dates spread evenly throughout the year and enumerated at the 1971 Census comprised the initial sample.

The present paper concentrates on a subset of the total LS population : women born in 1950 or later who were enumerated at both the 1971 and 1981 Censuses of England and Wales. Information on the births of these women registered in England and Wales have been linked together for purposes of analysis of fertility and infant mortality [16,17].

Due to inconsistencies in the recording of mothers date of birth at census and birth registration, linkage of births to sample mothers is not complete. Recent validation of the LS birth registration data suggests that between 1971-80, 94% of births were linked while between 1981-88 the equivalent figure was 86% [18]. Birth weight data for live births was first included in birth registration (and hence the LS) in 1976. By 1980, some 86% of singleton live births in the LS had birth weight, while by 1982, birth weight was available for 96% [17].

To maximise the number of women with complete fertility histories including birth weight, we restricted our analyses to women whose first or subsequent births linked into the LS occurred between 1980 and 1988, and who additionally did not record having already had a birth at the time of the 1971 Census in response to the retrospective fertility question [19]. We excluded 132 of these women as their first or second linked birth was a still birth, and 146 of them as their first or second maternity in the study period resulted in at least one set of multiple births.

Secondary analyses of the tabular data obtained from the OPCS were carried out using the SAS statistical package [20]. Standard errors and confidence intervals for means and proportions were calculated using standard methods.

Results

Between 1980 and 1988 21,338 women had a first live singleton birth linked into the LS. Over the same period, 10,498 of these women had a second live singleton birth linked in, birth weight being available for both births for 10,085 (96%). In addition, 1964 women had a third live singleton birth linked in, birth weight being available for all three births for 1826 (93%).

Among the women with missing birth weight data for one or more births there was a clear tendency for first birth weights to be missing. For women with two births, birth weight was missing for 3.8% of first births and 0.4% of second births, while for women with three births, birth weight was missing for 6.2% of first births, 1.3% of second births and 0.1% of third births. The probability of a birth weight being missing was unrelated to age of mother or social class of father at birth registration.

First and second births

The birth weight distribution of the first singleton live births is shown in table 1 together with the percentage within each birth weight category who went onto have a second birth. Among the 10,085 pairs of first and second live singleton births with stated birth weight, the mean birth weight for first births was 3275 grammes and for second births was 3402 grammes. Overall 60% of second births weighed the same or more than their corresponding first births.

There is a clear tendency for the birth weight of first and second births to be similar. This is shown in figure 2 which, following Skjaerven et al [12], shows the distribution of second birth weights in five categories according to the weight of the first birth. As first birth weight increases, there is a systematic shift to the right in the distribution of second birth weights, such that women with light first births tend to have light second births, while those delivering heavy first births tend to have heavy second births.

The distribution of differences in birth weight between the first and second birth for each woman (second birth weight minus first birth weight) is shown in figure 2 for each of the same five categories of first birth weight. This demonstrates a regression to the mean effect. Where first births weighed less than 2000 grammes, 97% of second births were heavier. As first birth weight increased, the percentage of second births that were heavier declined. Where first births weighed more than 4499 grammes only 11% of second births were heavier.

The regression to the mean effect and the tendency for women to repeat birth weights are summarised in table 2. This shows the mean birth weights for first and second births according to the weight of the first birth and the difference in mean birth weight between the two.

The relationships between first and second birth weights shown in table 2 are very robust. For example, the same effects are observed when analyses are restricted to pairs of births where both are boys or both are girls (not shown) or where the social class of the father at birth registration is the same at both births (table 3).

First, second and third Births

During the follow-up period, a total of 1826 women had three live singleton births all of whom had stated birth weights. The probability of a woman having a third birth in the study was inversely related to the weight of her first birth (table 1). Mean birth weights for first, second and third births stratified by weight of the first birth are shown in table 4, and in table 5 stratified by weight of the second birth. The tendencies for birth weights to repeat between first and second, second and third and first and third births are apparent as is the regression to the mean effect.

Among women with three live singleton births, the mean increase in birth weight from first to second births (194 grammes) is bigger than the mean increase from second to third births (57 grammes). Overall, 69% of second births weighed as much or more than their corresponding first births, while 65% of third births weighed as much or more than second births, 72% of third births weighed as much or more than first births.

The combined influence of the weight of first and second births on the weight of the third is shown in table 6. Here the mean weight of the third births are stratified according to the mean weight of the first and second births combined. As might be expected, the range of mean third birth weights from the lightest to the heaviest stratum (2881 to 3953 = 1072) is wider than the ranges across strata of first or second birth weights reported above. Moreover, consistent with this, there is evidence that the regression to the mean effect is attenuated : the mean weight of first and second births combined is even more strongly predictive of the weight of the third birth than are the weights of either the first or second alone.

Tendency to repeat low birth weight

Of particular clinical interest is the tendency to repeat low birth weight (ie. birth weights of less than 2500 grammes). Of the 10,085 women who had a first and second singleton live birth in the follow-up period, 6% of first births and 4% of second births were low birth weight

(LBW). Table 7 shows that where first births weighed less than 2500 grammes, 18.4% of second births also did so; these births accounting for 28% of all LBW second babies. Women whose first birth was LBW had a risk of their second birth also being LBW that was 5.9 times greater (95% CI 4.8 - 7.3) than women whose first birth was not LBW. The risk of a second birth being LBW declined steeply with increasing weight of the first birth.

Among women who had three live singleton births in the follow-up period, 8% of first, 5% of second and 5% of third were LBW. Women whose first birth was LBW had a much greater risk of their third birth being LBW than women whose first birth was not LBW (risk ratio = 3.4, 95% CI 2.1 - 5.7). The effect of a woman's second birth being LBW, relative to being not LBW, on the risk of her third birth being LBW was even stronger (risk ratio = 5.5, 95% CI 3.3 - 9.1).

The combined effects of a first and/or second birth being LBW on the risk of the third birth being LBW are shown in table 8. This shows the stronger effect of second compared to first births, but also shows that the combined effects are considerably greater than the effect of either first or second birth taken alone. Parallel analyses (not shown) for births of less than 2000 grammes showed similar effects, although the risk ratios tended to be slightly smaller.

Discussion

This analysis has compared weights of consecutive births in the period 1980-88, among a one percent sample of women enumerated at the 1971 Census of England and Wales who were born in 1950 or later. Births to women where birth weight was missing were excluded from the analyses, although those excluded did not differ appreciably from the rest of the sample in terms of maternal age or social class. There was a tendency for birth weight information to be missing for first births, mainly because first births were more likely to have been born in the early 1980s, when birth weight information in the LS was least complete [17]. This will not invalidate our findings with respect to the relationships seen between consecutive birth weights, and due to the relatively small proportion of excluded births (<5%), does not really limit the extent to which our findings may be generalised.

During the period 1980-88 it has been estimated that less than 90% of all births to sample mothers were linked into the OPCS Longitudinal Study. Thus, it is likely that some births which we believe to be first births, are in fact second or later births, and some sets of apparently consecutive births will in fact not be so. However, to be included in our analyses women had to have at least two births linked into the study. Misclassification of births to these women would only occur if they had had three or more births. As less than 10% of women with one birth go onto have a third, the extent of misclassification is limited. On the parsimonious assumption that the tendency to repeat birth weight is unrelated to the probability of having one or more births not linked into the study, the small degree of misclassification will lead to a dilution of any real effect.

We have found that there is a strong tendency for consecutive singleton live births to the same mother to be of similar weight. This tendency appears to be slightly stronger between second and third births than between first and second births. These effects are very robust, and are observed within pairs of first and second births where there is concordance of sex of infant or of social class of father at birth registration. The tendency to repeat is expressed in the substantially greater risk of having a second or third baby that is low birth weight when the first birth is low birth weight compared to when it is not.

This is the first time that the tendency to repeat birth weight has been reported in a representative national population sample other than for Norway. The first systematic study of this issue was published in 1951 [1]. Obstetric records from University College Hospital in London (1935-46) were used to study consecutive singleton births surviving to 28 days. Second and third birth weights were found to be more highly correlated than first and second (r=0.409 vs r=0.472). The study also showed that the risk of having a second baby that weighed less than 5.5 lbs was 6.2 times greater if the first birth was less than 5.5 lbs compared to if it was heavier. This figure is remarkably similar to our risk ratio of 5.9 for a second birth weighing less than 2500 grammes according to whether the first birth was LBW or not. Obstetric records from University College Hospital, London (1946-47) were also used to examine birth weight correlations between cousins [2], a correlation being found of r=0.502 between the birth weight of full sibs who had survived to one month.

Data from the Atomic Bomb Casualty Commission [9] was used to study births in Nagasaki and Hiroshima (1948-52). Correlations were found of r=0.52 between birth weights of adjacent singleton sibs, of r=0.43 where one other sib intervened, and of r=0.36 for two sibs intervening.

The Collaborative Perinatal Study [7] conducted in the US (1959-65) again found very similar tendencies to repeat among the 56 thousand births investigated. The risk ratios for low birth weight in second births stratified by weight of first birth are very close to ours (table 7), risk

Norwegian data [10,12]. The cross-sectional observation that on average second births are heavier than first births is sometimes presented as if it is a general rule that a woman's second birth will be heavier than her first. That this is not the case was stated clearly by Billewicz and Thomson [5]. What is very striking is that for first births over 3500 grammes, the majority of second births are lighter than the first.

From the outset [1], three broad types of explanation of the tendency to repeat birth outcome have been discussed. These are the role of continuity of external circumstances across consecutive pregnancies; the influence of fetal genotype, and the genetic similarity that exists between full sibs; and unidentified maternal factors. The evidence relating to each of these influences will be briefly considered in turn.

Continuity of circumstance across pregnancies.

A number of environmental factors in pregnancy such as smoking and maternal nutrition are known to effect birth weight. The cross-sectional data on smoking and birth weight [21] is reinforced by data [22] that suggests that the adverse effect of smoking on birth weight is reversible. However, despite this it has been suggested [8,23,24] that continuity in environmental factors such as smoking or maternal nutrition during pregnancy are unlikely to explain much of the tendency to repeat birth weight. This is consistent with our observation that the tendency to repeat is similar within strata of concordant social class groups. The possibility that the tendency to repeat may be mediated through complications in pregnancy or maternal ill health has also been considered in a number of studies [8,10,11,25]. However, all have concluded that the tendency to repeat is independent of such factors, including preeclampsia, vaginal bleeding, placental pathologies, placenta previa and anaemia.

Fetal genotype.

Similarities of fetal genotype in consecutive births are unlikely to make a substantial contribution to the tendency to repeat birth weights. A series of studies of birth weight correlations between full sibs, half-sibs and cousins have clearly shown that familial factors operating through the maternal line have a much greater effect on birth weight than any operating through the paternal line. Robson [2] found correlations of r=0.135 between birth weights of offspring of sisters, compared to a correlation of r=0.015 between birth weights of offspring to brothers. More convincingly, Morton [9] found that the correlation in birth weights among maternal half-sibs (r=0.581) was of the same order as between full sibs (r=0.523), while the correlation between paternal half-sibs was trivial (r=0.102).

Unidentified maternal factors.

By exclusion, the evidence discussed in the previous paragraph points strongly to the importance of maternal factors. The study of reciprocal crosses between Shire horses and Shetland Ponies, reported by Walton and Hammond [26] in 1938, remains the most graphic piece of evidence in favour of maternal factors having a profound influence on foetal growth. The offspring of the cross born to a small Shetland pony mare was very similar in weight to a pure Shetland foal in contrast to the offspring of the cross born to the much larger Shire mare which were considerably larger, although they did not reach the size of a pure Shire foal.

The concept of maternal factors in the regulation of foetal growth was developed by Ounsted and Ounsted [3]. Consistent with the results of the Shire-Shetland cross [26], they postulated that maternal factors operated by constraining the foetal growth rate to match that of the maternal strain. Thus, among infants who were large for gestational age, they found similar correlations between cousins related through the maternal and the paternal line. However, among infants who were small for gestational age, the correlations through the maternal line were much stronger than through the paternal line. More recent animal work [27] suggests that the constraining maternal influence on foetal growth operates principally in late gestation. Evidence of this effect in humans is found in studies of twins which suggest that their birth weight does not deviate from that of singletons until late in pregnancy [28-30].

Further evidence as to the importance of maternal factors in determining foetal growth comes from studies of the correlation of birth weight with parental height. For instance, Cawley et al [31], found that birth weight was more strongly correlated with maternal than paternal height. However, the correlations of adult height with paternal and maternal heights are relatively similar. Parallel to this, pooled data from a study of parental-child heights in 5 countries showed maternal height to be more strongly correlated with birth length than paternal height, this difference having disappeared by 9 years of age [32]. These effects are likely to be a result of 'catch-up' growth during childhood, where maternal constraints on genetic potential are to some degree transcended [33,34].

The maternal factors that influence foetal growth must in part be determined by maternal genotype. However, increasing attention is being given to the possibility that a woman's own intra-uterine experience may effect her own reproductive performance. Ounsted and Ounsted [25] found a correlation between maternal birth weight and the birth weight of her offspring which led them to suggest that the constraint imposed on foetal growth may reflect the degree of constraint experienced by the mother when she herself was a foetus. Subsequent studies have confirmed this result [35-37], and have found other evidence of an inter-generational effect including that grandmothers' height is independently associated with birth weight.

The strength of the effect of a woman's own birth weight on the birth weight of her own offspring estimated from data from the National Child Development Study in Britain [37], suggests an increase in birth weight of around 15 grammes for every 100 gramme increase in mother's birth weight. As noted by others [38], this is a relatively small effect, and it is therefore unlikely that a woman's own birth weight is closely related to the maternal factor responsible for the her own births to be of similar weight. It is also entirely plausible that nutrition and other factors in a woman's childhood may also play a role in setting the degree of maternal constraint imposed during her pregnancies.

In conclusion, our data confirm the existence of a powerful tendency to repeat birth weight. Little of this is likely to be explained by continuity across successive pregnancies of circumstances or exposures to known influences on birth weight. Instead, the evidence suggests that the effect of foetal genotype on birth weight appears circumscribed by one or more powerful factors, possibly transmitted through the maternal line, that operate to constrain foetal growth in the later stages of pregnancy. The nature of these maternal factors remains largely unknown, although they may be partly be related to a mother's own experience of growth restraint in utero or to conditions in childhood. Further understanding of this phenomenon will require more elaborate inter-generational studies with data on consecutive birth weights in two or more generations.

Acknowledgements

This paper forms part of the work on Health Inequalities Among Women and their Families supported by the ESRC under grant no. R000232797. The Longitudinal Study is used with the permission of the OPCS, the help and co-operation of whose staff is gratefully acknowledged. We would also like to thank Eva Alberman, Di Kuh, Paul McKeigue, Chris Power and Denny Vågerö for comments on earlier drafts.

References

1. Karn MN, Lang-Brown H, MacKenzie H, Penrose LS. Birth weight, gestation time and survival in sibs. Annals of Eugenics 1951;**15**:306-317.

2. Robson EB. Birth weight in cousins. Ann Hum Genet 1955;**19**:262-268.

3. Ounsted M, Ounsted C. On fetal growth rate. London: Heinemann Medical Books Ltd, 1973.

4. Billewicz WZ. A note on birth weight correlation in full sibs. J Biosoc Sci 1972;**4**:455-460.

5. Billewicz WZ, Thomson AM. Birthweights in consecutive pregnancies. Journal of Obstetrics and Gynecology of the British Commonwealth 1973;**80**:491-498.

6. Carr-Hill R, Samphier M. Birthweight and reproductive careers. J Biosoc Sci 1983;**15**:453-464.

7. Niswander KR, Gordon M. The women and their pregnancies. The collaborative perinatal study of the National Institute of Neurological Diseases and Stroke. Philadelphia: W.B.Saunders, 1972.

8. Khoury MJ, Calle EE, Joesoef RM. Recurrence of low birth weight in siblings. J Clin Epidemiol 1989;**42**:1171-1178.

9. Morton NE. The inheritance of human birth weight. Ann Hum Genet 1955;**20**:125-134.

10. Bakketeig LS, Hoffman HJ, Harley EE. The tendency to repeat gestational age and birth weight in successive births. Am J Obstet Gynecol 1979;**135**:1086-1103.

11. Bakketeig LS, Bjerkedal T, Hoffman HJ. Small-for-gestational age births in successive pregnancy outcomes : results from a longitudinal study of births in Norway. Early Human Development 1986;**14**:187-200.

12. Skjaerven R, Wilcox AJ, Russell D. Birthweight and perinatal mortality of second births conditional on weight of first. Int J Epidemiol 1988;**17**:830-838.

13. Skjaerven R, Bakketeig LS. Classification of small-for-gestational age births : weight-by-gestation standards of second birth conditional on the size of the first. Paed Perinat Epidemiol 1989;**3**:432-447.

14. Goldblatt P(ed). Longitudinal study : Mortality and Social Organisation, 1971-81 (OPCS Series No.6). London: HMSO, 1990.

15. Social Statistics Research Unit. Longitudinal Study User Manual. London: Social Statistics Research Unit, City University, 1990.

16. Bethune A, Filakti H, Harding S, Macdonald Davies I. Fertility and infant mortality in the OPCS Longitudinal Study. Pop Trends 1991;**68**:24-29.

17. Creeser R. The fertility and infant mortality datastream (FIMD). LS User Guide No. 9. London: Social Statistics Research Unit, City University, 1992.

18. Babb P, Hattersley L. An examination of the quality of the OPCS Longitudinal Study data for use in fertility analyses. LS Working Paper No. 73. London: Social Statistics Research Unit, City University, 1992.

19. Office of Population Censuses and Surveys. . In: Fertility report from the 1971 Census. Series DS No. 5. London: HMSO, 1983.

20. SAS Institute. SAS Procedures Guide for Personal Computers Version 6 edition. Cary, NC: SAS Institute Inc, 1985.

21. Brooke OG, Anderson HR, Bland JM, Peacock JL, Stewart CM. Effects on birth weight of smoking, alcohol, caffeine, socioeconomic factors, and psychosocial stress. Br Med J 1989;**298**:795-801.

22. Naeye RL. Effects of maternal cigarette smoking on the fetus and placenta. Br J Obstet Gynaecol 1978;**85**:732-737.

23. Seigel DG. A simple model for the interpretation of low birth weight repeater data. In: Reed DM, Stanley F eds. The epidemiology of prematurity. Baltimore: Urban and Schwarzenberg, 1977.

24. Khoury MJ, Beaty TH, Liang KY. Can familial aggregation of disease be explained by familial aggregation of environmental risk factors ?. Am J Epidemiol 1988;**127**:674-683.

25. Ounsted M, Ounsted C. Rate of intra-uterine growth. Nature 1968;**220**:599-600.

26. Walton A, Hammond J. The maternal effects on growth and conformation in Shire horse-Shetland pony crosses. Proc Roy Soc ,Lond 1938;**125**:311-335.

27. Snow MHL. Effect of genome on size at birth. In: Sharp F, Fraser RB, Milner RDG eds. Fetal growth. London: Royal College of Obstetricians and Gynaecologists, 1989. pp. 3-12.

28. McKeown T, Record RG. Observations on foetal growth in multiple pregnancy in man. J Endocrin 1951;**8**:386-401.

29. Naeye RL. The fetal and neonatal development of twins. Pediatrics 1964;**33**:546-553.

30. Fliegner JR, Eggers TR. The relationship between gestational age and birth-weight in twin pregnancy. Aust NZ J Obstet Gyaec 1984;**24**:192-197.

31. Cawley RH, McKeown T, Record RG. Parental size and birth weight. Am J Human Genet 1954;**6**:448-456.

32. Tanner JM, Goldstein H, Whitehouse RH. Standards for childrens' heights at ages 2-9 years allowing for height of parents. Arch Dis Childhood 1970;**45**:755-762.

33. Tanner JM. Catch-up growth in man. Brit Med Bull 1981;**37**:233-238.

34. Roberts SCD. Genetics of growth. Brit Med Bull 1981;**37**:239-246.

35. Klebanoff MA, Graubard BI, Kessel SS, Berendes HW. Low birth weight across generations. J Am Med Assoc 1984;**252**:2423-2427.

36. Hackman E, Emanuel I, van Belle G, Daling J. Maternal birth weight and subsequent pregnancy outcome. JAMA 1983;**250**:2016-2019.

37. Emanuel I, Filakti H, Alberman E, Evans SJW. Intergenerational studies of human birthweight from the 1958 birth cohort I. Evidence of a multigenerational effect. Br J Obstet Gynaecol 1992;**99**:67-74.

38. Carr-Hill R, Campbell DM, Hall MH, Meredith A. Is birth weight determined genetically?. Br Med J 1987;**295**:687-689.

Table 1 - Birth weight distribution of first singleton live births with stated birth weight, and percentage progressing to a second and third birth, OPCS Longitudinal Study, 1980-88.

Weight of first birth in grammes	Number of first live singleton births (percentage)	Percent progressing to 2nd live singleton birth *	Percent progressing to 3rd live singleton birth *
<2500	1369 (6.6)	45.7	10.5
2500-2999	4002 (19.2)	49.3	9.2
3000-3499	8490 (40.7)	48.9	9.0
3500-3999	5520 (26.5)	47.8	8.5
>3999	1466 (7.0)	47.9	5.7
Total	20847 (100.0)	48.4	8.8

* with stated birth weight

Table 2 - Mean birth weight (grammes) of second singleton live births in relation to birth weight of first singleton live births, OPCS Longitudinal Study, 1980-88.

Weight of first birth	Number of sets of 1st + 2nd births	Mean birth weight 1st births (SD)	Mean birth weight 2nd births (SD)	Mean of 2nd minus 1st
<2500	626	2030 (465)	2948 (590)	+918
2500-2999	1972	2787 (119)	3148 (457)	+361
3000-3499	4149	3251 (125)	3378 (461)	+127
3500-3999	2636	3714 (120)	3625 (455)	-89
>3999	702	4246 (212)	3820 (505)	-426
Total	10085	3275 (537)	3402 (522)	+127

Figures in parentheses are standard deviations in grammes.

Table 3 - Mean birthweight (grammes) of second singleton live births in relation to birth weight of first singleton live births, where social class of father was the same at registration of both births, OPCS Longitudinal Study, 1980-88.

Weight of first birth	Social class of father at birth registration of first and second singleton live birth											
	Non-manual			Manual			Other			Sole registrations		
	Number of sets	Mean weight 2nd birth	Mean of 2nd minus 1st	Number of sets	Mean weight 2nd birth	Mean of 2nd minus 1st	Number of sets	Mean weight 2nd birth	Mean of 2nd minus 1st	Number of sets	Mean weight 2nd birth	Mean of 2nd minus 1st
<2500	147	3036	+1000	345	2943	+891	5	3025	+1200	16	2703	+828
2500-2999	529	3184	+386	983	3255	+351	42	3137	+345	52	3110	+331
3000-3499	1339	3413	+162	1928	3366	+114	67	3397	+123	124	3270	+36
3500-3999	864	3664	-50	1277	3621	-94	48	3557	-177	43	3561	-163
>3999	252	3872	-377	308	3821	-413	14	3732	-482	8	3406	-906
Total	3131	3434	+224	4841	3377	+170	176	3370	+202	243	3210	+24

Table 4 - Mean birth weight (grammes) of second and third singleton live births in relation to birth weight of first singleton live births for women with three live singleton births, OPCS Longitudinal Study, 1980-88.

Weight of first birth	Number of sets of 1st,2nd + 3rd births	Mean birth weight 1st birth	Mean birth weight 2nd birth	Mean birth weight 3rd birth	Mean of 2nd minus 1st	Mean of 3rd minus 1st
<2500	144	2024 (478)	2887 (691)	3016 (492)	+863	+992
2500-2999	368	2787 (120)	3100 (506)	3183 (508)	+313	+396
3000-3499	761	3242 (125)	3346 (470)	3390 (525)	+104	+148
3500-3999	469	3715 (120)	3572 (451)	3610 (514)	-143	-105
>3999	84	4253 (247)	3848 (457)	3881 (529)	-405	-372
Total	1826	3222 (545)	3341 (544)	3398 (556)	+119	+194

Figures in parentheses are standard deviations in grammes.

Table 5 - Mean birth weight (grammes) of first and third singleton live births in relation to birth weight of second singleton live births for women with three live singleton births, OPCS Longitudinal Study, 1980-88.

Weight of second birth	Number of sets of 1st,2nd + 3rd births	Mean birth weight 1st birth	Mean birth weight 2nd birth	Mean birth weight 3rd birth	Mean of 1st minus 2nd	Mean of 3rd minus 2nd
<2500	93	2668 (650)	1929 (508)	2888 (554)	+739	+959
2500-2999	292	2903 (552)	2800 (115)	3074 (492)	+103	+274
3000-3499	733	3195 (457)	3254 (125)	3327 (496)	-59	+73
3500-3999	549	3402 (458)	3723 (122)	3616 (469)	-321	-107
>3999	159	3637 (515)	4246 (194)	3864 (538)	-609	-382
Total	1826	3222 (545)	3341 (544)	3398 (556)	-119	+57

Figures in parentheses are standard deviations in grammes.

Table 6 - Mean birth weight (grammes) of third singleton live births in relation to mean birth weight of first and second singleton live births, OPCS Longitudinal Study, 1980-88.

Mean weight of first and second birth	Number of sets of 1st, 2nd + 3rd births	Mean birth weight 1st + 2nd birth	Mean birth weight 3rd birth	Mean of 3rd minus mean of 1st + 2nd
<2500	83	2087 (313)	2881 (527)	+794
2500-2999	258	2751 (128)	2983 (490)	+232
3000-3499	791	3199 (134)	3337 (491)	+138
3500-3999	591	3644 (131)	3635 (467)	-9
>3999	103	4127 (175)	3953 (508)	-174
Total	1826	3282 (461)	3398 (556)	+116

Figures in parentheses are standard deviations in grammes.

Table 7 - Risk of second birth weighing less than 2500 grammes according to weight of first birth, OPCS Longitudinal Study, 1980-88.

Weight of first birth	Number of sets of 1st + 2nd births	Percentage of 2nd births <2500 grammes	Risk ratio * (95% CI)	Percentage of all 2nd births <2500 grammes
<2500	626	18.4	16.7 (8.2 - 34.2)	28.1
2500-2999	1972	6.8	6.2 (3.0 - 12.7)	32.8
3000-3499	4149	2.8	2.5 (1.2 - 5.1)	28.4
3500-3999	2636	1.4	1.3 (0.6 - 2.8)	8.8
>3999	702	1.1	1.0	1.9

* Risk ratios relative to those where first birth weighed >3500 grammes.

Table 8 - Risk of third birth weighing less than 2500 grammes according to whether first and second births weighed less than 2500 grammes, OPCS Longitudinal Study, 1980-88.

First birth	Second birth	Number of sets of 1st, 2nd and 3rd births	Percentage of 3rd births <2500 grammes	Risk ratio * (95% CI)
Not LBW	Not LBW	1621	3.6	1.0
LBW	Not LBW	112	8.9	2.5 (1.3 - 4.9)
Not LBW	LBW	61	16.4	4.6 (2.3 - 9.0)
LBW	LBW	32	31.2	8.7 (4.5 - 17.1)

* Risk ratios relative to third births where first and second birth both weighed 2500+ grammes.

Figure 1. Distribution of weights of second births conditional upon weight of first birth. Live singleton births, 1980-88.

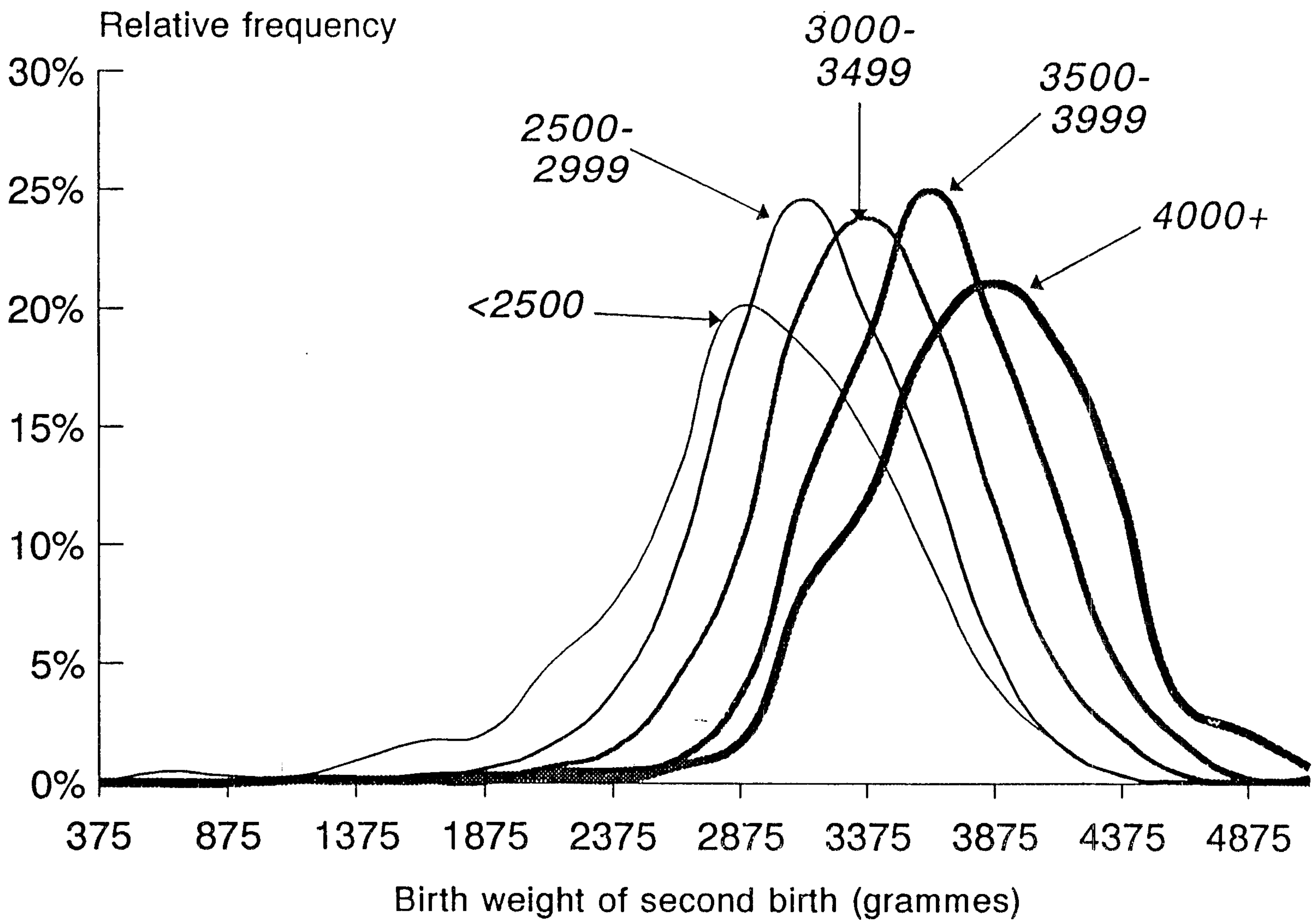

Figure 2. Difference in weight between first and second births conditional upon weight of first birth. Live singleton births, 1980-88.