

Pregnancy: occupational aspects of management: concise guidance

Keith T Palmer, Matteo Bonzini and Jens-Peter Ellekilde Bonde, on behalf of a multidisciplinary Guideline Development Group convened by, and in association with, the Health and Work Development Unit, a collaboration between the Royal College of Physicians and the Faculty of Occupational Medicine

ABSTRACT – Most pregnant women are exposed to some physical activity at work. This Concise Guidance is aimed at doctors advising healthy women with uncomplicated singleton pregnancies about the risks arising from five common workplace exposures (prolonged working hours, shift work, lifting, standing and heavy physical workload). The adverse outcomes considered are: miscarriage, preterm delivery, small for gestational age, low birth weight, pre-eclampsia and gestational hypertension. Systematic review of the literature indicates that these exposures are unlikely to carry much of an increased risk for any of the outcomes, since small apparent effects might be explicable in terms of chance, bias, or confounding, while larger and better studies yield lower estimated risks compared with smaller and weaker studies. In general, patients can be reassured that such work is associated with little, if any, adverse effect on pregnancy. Moreover, moderate physical exercise is thought to be healthy in pregnancy and most pregnant women undertake some physical work at home. The guidelines provide risk estimates and advice on counselling.

KEY WORDS:

Background

In the UK, as in most parts of the world, women comprise a substantial proportion of the modern workforce (47.6% in Spring, 2010),¹ with an estimated 350,000 pregnant women working each year.² Several reproductive hazards associated with

Keith T Palmer,¹ professor of occupational medicine; Matteo Bonzini,² assistant professor of occupational medicine; Jens-Peter Ellekilde Bonde,³ professor of occupational medicine and consultant occupational physician; Guideline Development Group⁴

¹Medical Research Council Lifecourse Epidemiology Unit, University of Southampton; ²Epidemiology and Preventive Medicine Research Centre, University of Insubria; ³Department of Occupational and Environmental Medicine, Bispebjerg Hospital; ⁴Ira Madan, consultant in occupational medicine, Guy's and St Thomas' NHS Foundation Trust; Nadia Sheikh, consultant in occupational medicine, Barts Health NHS Trust; Elaine Scott, consultant obstetrician and gynaecologist, Royal Free London NHS Foundation Trust; Susan Murray, Trades Union Congress; Sara Hoffbrand, general practitioner; Elizabeth Duff, senior policy adviser, National Childbirth Trust; Karen Walker-Bone, consultant rheumatologist; Jane Munro, Royal College of Midwives; Sian Williams, clinical director, Health and Work Development Unit, Royal College of Physicians

work are well established (eg from ionising radiation and lead) and particular strategies have been developed to manage the associated risks. However, there are other potential workplace hazards for which the scientific evidence is less certain.

Important among these is the possibility that physical activities at work might adversely affect outcomes of pregnancy.³ It has been suggested, for example, that women's work schedules (including rotating shifts and night work) can induce neuroendocrine changes as a consequence of sleep deprivation or disrupted circadian rhythms, affecting fetal growth and the timing of parturition. In theory, long working hours, prolonged standing, heavy lifting or an unusual workload might also pose several threats to pregnant workers. The high demand for uterine and placental blood flow during the third trimester could limit reserve capacity for vigorous exercise, whereas raised noradrenaline levels could increase uterine contractility and, thereby, the risk of preterm labour. By contrast, marked physiological adaptations to the demands of pregnancy tend to preserve constant fetal oxygen consumption.

Provision of appropriate information to the pregnant worker is made more difficult because most of the activities of concern (especially physical exertion), although suspected of being hazardous, could also be beneficial, as suggested in other contexts by several reviews.^{4–7} Thus, advice on avoiding work activity could, in theory, be detrimental and cause needless anxiety.

Scope of the guidelines

This Concise Guidance is aimed at clinicians advising healthy women with uncomplicated singleton pregnancies about the relative safety of physical factors at work. Women with comorbidities, a previous adverse obstetric history or complications in the present pregnancy, including multiple pregnancies, should seek specialist advice from their obstetrician or midwife. Further information has also been provided by the National Institute for Health and Clinical Excellence (NICE) and the National Collaborating Centre for Women's and Children's Health.⁸

Box 1 provides definitions of the terms commonly used in these guidelines.

Evidence synthesis and rationale

The evidence synthesis underpinning the present guidelines has been built on, and extends, three previous reviews on occupational activity and pregnancy outcome.^{3,9,10} It relates to five

occupational exposures (working hours, shift work, lifting, standing and physical workload) that are all common among women of reproductive age. For example, in 2010, 16% of working women aged 15–39 years undertook shifts in their main job ‘most of the time’¹¹ and 10% of women in full-time jobs worked more than 40 h/wk.¹¹

The chosen outcomes (miscarriage, preterm delivery, small for gestational age (SGA), low birth weight (LBW), pre-eclampsia and/or gestational hypertension) are important to the health of the fetus, neonate and mother. Preterm birth is the most important single determinant of adverse infant outcome in terms of both survival and quality of life.^{12,13} LBW is a cause of infant morbidity and mortality,¹⁴ as well as predicting adverse outcomes in later life (eg poorer growth and development, neurological and cognitive deficit, high blood pressure, noninsulin-dependent diabetes, coronary heart disease, stroke and obstructive lung disease);¹⁵ pre-eclampsia and eclampsia were responsible for 8.4% of maternal deaths in the UK during 2006–2008;¹⁶ and miscarriage can cause enduring psychological distress. As

Box 1. Terms and definitions commonly used in the research supporting these guidelines.

Preterm delivery: birth of a living fetus before 37 completed weeks of gestation

Small-for-gestational age (SGA): birth weight below the 10th centile on the expected distribution of birth weights by duration of gestation

Low birth weight (LBW): birth weight <2,500 g

Pregnancy-induced hypertension: gestational hypertension (elevation of blood pressure in a previously normotensive woman that occurs after the 20th week of gestation and resolves after delivery) in the absence of proteinuria

Pre-eclampsia: gestational hypertension with proteinuria and oedema

Miscarriage: pregnancy loss after recognition of pregnancy and before the 24th week of gestation*

Prolonged standing: ≥4 h per day in total (>6 h per day for miscarriage)

Prolonged working hours: ≥40 h/wk

Shift work: night-shift working, evening-shift work, rotating-shift work

Fixed night-shift work: work always at night

Three-shift schedule: a rotational shift pattern involving time worked in blocks, sometimes during the day, sometimes during the evening and sometimes at night

Heavy lifting and heavy physical workload: the evidence base in the occupational setting does not permit exact definitions. However, the Royal College of Obstetrics and Gynaecology (RCOG) advises in relation to sustained exertion that recreational exercise in pregnancy should allow the woman still to conduct a conversation, be ‘somewhat hard’ (ie ‘quite an effort/feel tired, but can continue’, on the Borg scale of perceived exertion), should be in a target heart-rate range defined by maternal age if aerobic (not >155 beats/min in 20-year-olds, not >140 beats/min in >40-year-olds), should not precipitate unusual symptoms (eg dizziness or palpitations), and should include warm-up and cool-down phases.²³ In relation to ‘heavy lifting’, the HSE does not give specific guidance for pregnant workers, but a ‘typical’ load in studies that provided such detail was approximately 10–12 kg (a weight that is not uncommonly lifted in the home by pregnant women with toddlers).

*Studies used various definitions, ranging from 20 to 28 weeks.

well as being important, these adverse pregnancy outcomes are also common: 6.7% of live singleton births in hospitals in England during 2010–2011 were complicated by prematurity; 6.7% involved gestational hypertension and/or pre-eclampsia; and 6.6% of birth weights were <2,500 g;¹⁷ in addition, 10–14% of recognised pregnancies end in miscarriage.¹⁸

Current European Union (EU) legislation (92/85, EEC) and the related Management of Health and Safety at Work Regulations 1999 and guidance from the Health and Safety Executive (HSE)¹⁹ require employers to assess health and safety risks to pregnant workers, and to control them. However, there is currently limited advice for clinicians who care for healthy pregnant workers.²⁰

Guideline development

Two systematic searches in Medline and EMBASE (January 1966 to June 13th 2012 for miscarriage, January 1966 to December 31st 2011 for other outcomes) identified 113 overlapping reports relating to these work exposures and pregnancy outcomes: 57 reports on preterm delivery, 54 on birth weight, 30 on miscarriage and 11 concerning pre-eclampsia or gestational hypertension. Eligible studies were critically assessed for their completeness of reporting and potential for bias and confounding following previously published methods,^{9,10} adapted in part from SIGN methodology and elements proposed by Ariens *et al.*²¹ and van der Windt *et al.*²² For studies with similar definitions, pooled meta-estimates of relative risk (RR) were calculated, updating earlier computations.⁹ A multidisciplinary stakeholders group, comprising representatives from obstetrics, midwifery, general practice, general medicine, occupational medicine, the Royal College of Physicians (RCP), the trades union movement and the public (a representative from the parents’ charity National Childbirth Trust (NCT)), formulated these guidelines in light of the evidence.

Appraisal of the evidence

The evidence base is extensive for preterm delivery, LBW and SGA, more limited for miscarriage, and very limited for pre-eclampsia and gestational hypertension. It has several strengths: pregnancy outcomes were usually confirmed from objective sources, most studies were well reported, response rates were typically high and studies were often large. By contrast, nearly half of reports were potentially affected by confounding or bias and the exposures ‘occupational lifting’, ‘physical workload’ and even ‘shift work’ were not defined uniformly between studies.

Within these limitations (and strengths), findings were broadly reassuring. For preterm delivery, pooled estimates tended to indicate no more than modest elevations in risk (eg RR <1.2 or ≤1.3 extra case per 100 deliveries to exposed women). The larger and most complete studies reported the smallest levels of risk, suggesting that risk estimates in other studies were inflated by bias. For SGA, meta-estimates were close to the no-effect level. For miscarriage, meta-risk estimates were elevated moderately

Table 1. Table of evidence.

Grade†	Statement
There might potentially* be a small increased risk of preterm delivery and miscarriage from working for more than 40 h/wk during pregnancy.	
A	The potential* risk of preterm delivery is estimated to be 1.2 extra cases (95% CI 0.3 to 2.2) in every 100 deliveries to women working more than 40 h/wk.
A	Available evidence does not indicate an increase in risk in relation to SGA (−0.1 extra cases (95% CI −1.2 to 1.1) in every 100 deliveries to women working more than 40 h/wk).
B	The potential* risk of miscarriage is estimated to be 2.0 extra cases (95% CI −2.4 to 8.5) in every 100 pregnancies to women working more than 40 h/wk.
There might potentially* be an increased risk of miscarriage and also a very small increased risk of preterm delivery from shift working, including night-shift working.	
A	The potential* risk of preterm delivery is estimated to be 0.3 extra cases (95% CI −0.4 to 1.0) in every 100 deliveries to women who work shifts.
A	Available evidence does not indicate an increase in risk in relation to SGA (−0.2 extra cases (95% CI −1.1 to 0.8) in every 100 deliveries to women with that exposure).
B	The potential* risk of miscarriage is estimated to be 1.4 extra cases (95% CI −0.5 to 3.6) in every 100 pregnancies to women working a 3-shift schedule.
C	The potential* risk of miscarriage is estimated to be 6.1 extra cases (95% CI 3.2 to 9.4) in every 100 pregnancies to women with a fixed night shift schedule.
There might potentially* be a small increased risk of preterm delivery, SGA and of miscarriage from prolonged standing at work.	
A	The potential* risk for preterm delivery is estimated to be 0.9 extra cases (95% CI −0.1 to 1.9) in every 100 deliveries to women undertaking prolonged standing (>4 hours/day) at work.
A	The potential* risk for SGA is estimated to be 1.6 extra cases (95% CI −0.3 to 3.8) in every 100 deliveries to women undertaking prolonged standing (>4 hours/day) at work.
C	The potential* risk for miscarriage is estimated to be 1.9 extra cases (95% CI 0.1 to 3.8) in every 100 pregnancies to women undertaking prolonged standing (>6 hours/day) at work.
There might potentially* be a very small increased risk of preterm delivery, SGA and miscarriage from heavy lifting¶ at work.	
B	The potential* risk is estimated to be 0.1 extra cases (IQR −0.7 to 2.0) of preterm delivery in every 100 deliveries to women who undertake heavy lifting at work.
B	The potential* risk is estimated to be 0.8 extra cases (IQR 0.4 to 1.6) of SGA in every 100 deliveries to women who undertake heavy lifting at work.
B	The potential* risk is estimated to be 0.2 extra cases (95% CI −3.2 to 5.3) of miscarriage in every 100 pregnancies to women lifting >100 kg/d.
There might potentially* be a small increased risk of preterm delivery and miscarriage among women with a heavy physical workload¶ at work.	
B	The potential* risk of preterm delivery is estimated to be 0.7 extra cases (IQR 0.3 to 1.1) in every 100 deliveries to women with a heavy physical workload.
B	Available evidence does not indicate an increase in risk in relation to SGA (−1.2 extra cases (IQR −1.9 to 0.0) in every 100 deliveries to women with a heavy physical workload).
C	The potential* risk of miscarriage is estimated to be 1.4 extra cases (IQR −8.2 to 2.4) in every 100 pregnancies to women with a heavy physical workload.
D	Pregnant women can be advised that there is insufficient evidence to draw firm conclusions about the effect of long working hours, shift work, prolonged standing, lifting and heavy physical work, on risks of pre-eclampsia and gestational hypertension, although such evidence as exists suggests that risks are no more than small.

95% CI – 95% confidence interval; GPP – good practice point (as advised by the Guideline Development Group); IQR – interquartile range.

*Uncertainty in risk estimation reflects both the amount of evidence (and play of chance) and its quality (eg vulnerability to bias or confounding variables). The numbers capture the effect of chance assuming that there is no bias (which might not be so): where a negative number is quoted, risk estimates appear compatible with a benefit from the activity; estimates of uncertainty that straddle 0.0 at their confidence limits (or IQR) might arise by chance in the absence of a true effect. The grading reflects the overall weight, quality and consistency of evidence.

†The grading system was adapted from SIGN by the Guideline Development Group: A, a substantial and consistent body of observational evidence at approximately grade 2+, supported by one or several high-quality systematic reviews with meta-estimates of effect; B, as A, but without meta-estimates of effect; or as A, but with fewer, but a still reasonably large number of studies; C, a small body of observational evidence at approximately grade 2+ tending in the same direction (with or without accompanying meta-analysis); D, a very small body of observational evidence. Estimated numbers of excess cases per 100 deliveries to exposed women are based where available on meta-estimates from higher quality studies, with 95% CI, and otherwise on the median and IQR across all relevant studies. The estimates assume a prevalence of singleton live preterm delivery of 6.7%,¹⁷ a prevalence of SGA of 10% and a prevalence of miscarriage of 12%.²⁷

¶The evidence base does not allow exact definition of heavy lifting or physical workload, but the National Collaborating Centre for Women's and Children's Health and NICE advise that 'beginning or continuing a moderate course of exercise during pregnancy is not associated with adverse outcomes'.²⁸

Table 2. Recommendations advising pregnant women.

Grade	Statement
A	Pregnant women can be reassured that current evidence offers no justification for imposing mandatory restrictions in relation to their working hours, shift working, lifting, standing and physical workload at work.
GPP	Pregnant women can be informed that it is uncertain whether long working hours, shift work, prolonged standing, lifting and heavy physical work increase risks for preterm delivery, SGA, miscarriage and pre-eclampsia and/or gestational hypertension to a small degree. Best estimates generally suggest small increases in risk, but typically the data are also compatible with no effect (or even a small benefit) from work. There might also be disadvantages in refraining from work, which need to be considered (see main text). Thus, advice on work avoidance should be tailored to each patient's tolerance of uncertainty at apparently low levels of risk, and the anxiety or otherwise that this engenders.
GPP	In communicating risk information to pregnant women, a structured approach is recommended, covering the background level of risk in unexposed women, best estimates of any excess risk with uncertainties (both in the estimate of risk and in the quality of evidence), and any follow-on advice (see Box 2).
GPP	Women with an adverse obstetric history or with obstetric risk factors and/or pregnancy complications need to receive individualised advice from their obstetrician or midwife.
GPP	Regardless of any potential risks to the fetus, the physiological demands of late pregnancy (after 28 weeks' gestation) are such that women might struggle to cope with excessive work demands, such as: long working hours (eg >40 h/wk); shift work; prolonged standing (eg >4 h/d); heavy physical work and heavy lifting. A good case exists for limiting them, and employers should have regard to making reasonable adjustments to the worker's job profile.

Box 2. Available information sheets for professionals.

- Heavy lifting and the risk of miscarriage, preterm delivery and small for gestational age
- Heavy physical workload at work and the risk of miscarriage and preterm delivery
- Long working hours and the risk of miscarriage and preterm delivery
- Shift work and the risk of miscarriage and preterm delivery
- Prolonged standing at work and the risk of miscarriage, preterm delivery and small for gestational age

All these information sheets are available at www.rcplondon.ac.uk/pregnancyguidelines.

overall, but generally lower in better quality studies ($RR < 1.2$); higher risks were implied from working fixed night shifts, but in only a few studies, each with individual limitations ($RR 1.5$). For pre-eclampsia and gestational hypertension, there were insufficient data to draw firm conclusions, although risks were seldom much elevated.

Table 1 presents evidence showing the best estimates of the excess risk (per 100 exposed women), together with an assessment of the strength of evidence and statistical uncertainty. In summary, none of the exposures appeared likely to carry much of an increased risk for any of the outcomes. Although small levels of excess risk might exist for preterm delivery, SGA, LBW and miscarriage, it is possible that many or all of these effects arise from a combination of chance, bias and residual confounding. (Even in the absence of bias or confounding, estimates of effect embrace the possibility of no effect or even a small benefit from many of the activities of interest.)

Legal position

Employers have an ongoing duty to assess and control risks to their employees' health and safety arising from their work. They also have a specific obligation in relation to pregnant workers (Management of Health and Safety at Work Regulations 1999), which extends where necessary and feasible to the offer of alter-

native work or, failing this, medical suspension with pay and job protection (Employment Rights Act 1996). This obligation might require employers to search for suitable alternative daytime work for a pregnant shift worker certified by a doctor or midwife as unfit to work nights.¹⁹ According to Directgov,²³ lifting, carrying, standing, working hours and shift work bear consideration in employers' risk assessments of pregnant workers; similarly, HSE cautions that risks can arise from working conditions, including manual handling and working hours.²⁴

The issues in context

However, the evidence base supporting mandatory medical restriction for the work activities covered by this guideline is weak. Such advice should not be issued without careful consideration, because some women might become anxious and unnecessary avoidance of work might ensue. By inference, also, similar physical activities outside work might seem contraindicated, whereas the Royal College of Obstetricians and Gynaecologists²⁵ and the American College of Obstetricians and Gynaecologists²⁶ recommend that 'all women should be encouraged to participate in aerobic and strength-conditioning exercise as part of a healthy lifestyle during their pregnancy' and that 'reasonable goals' of aerobic conditioning should be maintained; these appear to confer physical and psychological benefits (eg reduced fatigue, varicosities, swelling of extremities, insomnia, stress, anxiety and depression, perhaps even length of labour and delivery complications²⁵).

On the other hand, outcomes such as preterm delivery can have important health consequences and patients will differ in their understanding and tolerance of uncertainty at apparently low levels of risk. In general, the evidence base is reassuring, especially given the potential disadvantages of refraining from work activities. Some women might remain clinically anxious and need tailored individual counselling, or a choice, for example, of moving from fixed night working to an alternative work pattern. In any event, many women will need to reduce

long working hours, prolonged standing and heavy physical work, particularly during late pregnancy when physical stamina limits capacity for onerous duties.

Recommendations

In relation to healthy uncomplicated singleton pregnancies, the Guideline Development Group has drawn up the recommendations detailed in Table 2.

Coherence with other advice

These recommendations are consistent with previous recommendations issued on behalf of the RCP and NHS Plus in 2009 in relation to the same exposures and outcomes.¹⁸ However, the evidence base supporting them is deeper, enabling firmer conclusions to be drawn.

Implementation

No specific issues arise in relation to implementation, because the emphasis will largely be on allaying concerns raised by the patient, rather than some more proactive policy; and the advice recommended carries no resource implications for the advising clinician.

Information sheets for professionals for each exposure (Box 2) outlining any evidence on risk in relation to the outcomes covered by the literature review have been prepared, and are available on the RCP website at www.clinmed.rcpjournals.org. The advice given in the information sheets is designed to be used by professionals when advising women with a healthy, uncomplicated, singleton pregnancy.

Acknowledgments

This guideline was developed with funding from the NHS Health at Work Network.

References

- 1 Economic and Social Data Service. *Labour force survey: quarterly household dataset, April–June 2010*. London: Office for National Statistics, 2010.
- 2 Department of Trade and Industry. *Work and Parents: Competitiveness and Choice. Research and Analysis*, Nov 2000. London: DTI, 2000.
- 3 Mozurkewich EL, Luke B, Avni M et al. Working conditions and adverse pregnancy outcome: a meta-analysis. *Obstet Gynecol* 2000;95:623–34.
- 4 Kramer MS, McDonald SW. Aerobic exercise for women during pregnancy. *Cochrane Database Syst Rev* 2006;3:CD000180.
- 5 Chasan-Taber L, Evenson KR, Sternfeld B et al. Assessment of recreational physical activity during pregnancy in epidemiologic studies of birth weight and length of gestation: methodologic aspects. *Women Health* 2007;45:85–107.
- 6 Schlussel MM, de Souza EB, Reichenheim ME et al. Physical activity during pregnancy and maternal–child health outcomes: a systematic literature review. *Cad Saude Publica* 2008;24(suppl 4):531–44.
- 7 Lagerros YT. Physical activity: the more we measure, the more we know how to measure. *Eur J Epidemiol* 2009;24:119–22.
- 8 National Institute for Health and Clinical Excellence. *Antenatal care. Routine care for the healthy pregnant woman*. London: NICE, 2008.
- 9 Bonzini M, Coggon D, Palmer KT. Risk of prematurity, low birth weight, and pre-eclampsia in relation to working hours and physical activities: a systematic review. *Occup Environ Med* 2007;64:228–43.
- 10 Bonzini M, Palmer KT, Coggon D et al. Shift work and pregnancy outcomes: a systematic review with meta-analysis of currently available epidemiological studies. *BJOG* 2011;118:1429–37.
- 11 Annual Survey of Hours and Earnings, 2010. www.ons.gov.uk/ons/publications/re-reference-tables.html?edition=tcm%3A77-238620 [Accessed 19 November 2012].
- 12 Saigal S, Doyle LW. An overview of mortality and sequelae of preterm birth from infancy to adulthood. *Lancet* 2008;371:261–9.
- 13 Costeloe K, EPICure Study Group. EPICure: facts and figures: why preterm labour should be treated. *BJOG* 2006;113(suppl 3):10–2.
- 14 Moser K, Li L, Power C. Social inequalities in low birth weight in England and Wales: trends and implications for future population health. *J Epidemiol Community Health* 2003;57:687–91.
- 15 Barker DJB, ed. *Fetal and infant origins of adult disease*. London: BMJ Publishing Group, 1992.
- 16 Centre for Maternal and Child Enquiries (CMACE). Saving Mothers Lives: reviewing maternal deaths to make motherhood safer: 2006–2008. The Eighth Report of the Confidential Enquiries into Maternal Deaths in the United Kingdom. *BJOG* 2011;118 (suppl 1):1–203.
- 17 Hospital Episode Statistics 2011. Table 22: Complications recorded in the pregnancy episode, 2010–11, NHS Hospitals, England; Table 28: Singleton and multiple deliveries by birth weight and birth status, 2010–11, NHS Hospitals, England.
- 18 Wilcox A. *Fertility and pregnancy – an epidemiological perspective*. Oxford: Oxford University Press, 2010.
- 19 Health and Safety Executive. *New and expectant mothers: the law*. London: HSE, 1999.
- 20 Royal College of Physicians, NHS Plus. *Physical and shift work in pregnancy: occupational aspects of management. A national guideline*. London: RCP, 2009.
- 21 Ariens G, van Mechelen W, Bongers PM et al. Physical risk factors for neck pain. *Scand J Work Environ Health* 2000;26:7–19.
- 22 Van der Windt DAWM, Thomas E, Pope DP et al. Occupational risk factors for shoulder pain: a systematic review. *Occup Environ Med* 2000;57:433–42.
- 23 Directgov, 2012. www.direct.gov.uk/en/Parents/Moneyandworkentitlements/WorkAndFamilies/Pregnancyandmaternityrights/DG_10026556 [Accessed 19 November 2012].
- 24 Health and Safety Executive, 2012. www.hse.gov.uk/mothers/faqs.htm [Accessed 19 November 2012].
- 25 Royal College of Obstetricians and Gynaecologists, 2006. www.rcog.org.uk/files/rcog-corp/Statement4-14022011.pdf [Accessed 19 November 2012].
- 26 Aratal R, O'Toole M. Guidelines of the American College of Obstetricians and Gynaecologists for exercise during pregnancy and the postpartum period. *Br J Sports Med* 2003; 37:6–12.
- 27 Regan L, Braude PR, Trembath PL. Influence of past reproductive performance on risk of spontaneous abortion. *BMJ* 1989; 299:541–5.

Address for correspondence: Professor K Palmer,
MRC Lifecourse Epidemiology Unit,
Southampton General Hospital, Tremona Road,
Southampton, Hampshire SO16 6YD.
Email: ktp@mrc.soton.ac.uk