Original Contribution

Reproductive History and Mortality in Late Middle Age among Norwegian Men and Women

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There is growing recognition that reproductive patterns may have long-term health implications, although most evidence is restricted to women. The authors used register data to derive fertility histories for all Norwegian men and women born in 1935–1958. Discrete-time hazard modeling was used to analyze later-life mortality by aspects of reproductive history. A total of 63,312 deaths were observed during 14.5 million person-years of follow-up in 1980–2003, when subjects were aged 45–68 years. Models included detailed information on educational qualifications and marital status. Odds of death relative to those for subjects with two children were highest for the childless (women: odds ratio (OR) = 1.50, 95% confidence interval (CI): 1.43, 1.57; men: OR = 1.35, 95% CI: 1.30, 1.40) and next highest for those with only one child (women: OR = 1.31, 95% CI: 1.26, 1.37; men: OR = 1.20, 95% CI: 1.16, 1.24). Results for the parous showed a positive association between earlier parenthood and later mortality, a reverse association with late age at last birth, and an overall negative association between higher parity and mortality. The similarity of results for women and men suggests biosocial pathways underlying associations between reproductive history and health. The lack of any high-parity disadvantage suggests that in the “family friendly” Norwegian environment, the health benefits of having several children may outweigh the costs.

Men; middle aged; mortality; Norway; parity; registries; reproductive history; women

Abbreviations: CI, confidence interval; OR, odds ratio.

Family status has been linked with health and mortality in both theoretical and empirical studies for well over a century (1, 2). Extensive evidence shows health benefits of marriage, especially for men, and, to a lesser extent, suggests advantages of living with children, at least for those with a partner (3–8). The number of children born and the timing of births may also have implications for health in later life. It is well established that nulliparity and late childbearing are associated with higher risks of breast cancer, and high parity appears protective against some other hormonally related cancers (9–12). High parity and early childbearing are, however, associated with higher risks of diabetes and circulatory diseases, although underlying mechanisms are not clearly established (13).

Apart from specific biologic links between aspects of female reproductive history and particular diseases, other biosocial pathways may link reproductive patterns and the later mortality of both women and men. For example, child rearing may provide an impetus to avoid health-damaging behaviors and often involves greater social participation in the community (14, 15). We would expect accumulated effects of such behavioral patterns to be apparent later in life. Additionally, social support from children is associated with health benefits at older ages (16, 17). Less positively,
reproduction involves physical stress on mothers (18); in addition, for both women and men, child rearing, or certain patterns of child rearing, may involve increased exposures to infections; stress, with associated higher risks of depression; and substantial economic costs (19–21).

A number of studies of contemporary developed-country populations have examined associations between aspects of reproductive history and later-life mortality or health (22–29). Reviews of this literature have reported that, although most studies suggest later disadvantages for nulliparous and high-parity women, the evidence is far from conclusive (30, 31). A few studies have also shown a disadvantage for mothers of one child only (9, 26), and a recent Finnish study of women with five or more children reported below-average all-cause mortality (32).

Interpretation of these studies is complicated by varying control for socioeconomic and marital status and for other potentially confounding factors. For example, socioeconomic status is associated with differentials in the timing of fertility and total number of births, as well as with mortality, and should be controlled for (33, 34). Women (and men) who start childbearing at younger ages have higher total parities on average, so control for this factor is also desirable, especially because studies that have examined age at childbearing have consistently shown poorer later health and higher mortality for women with an early entry to motherhood (25, 26, 29, 35, 36). Later health disadvantages of early fatherhood have also been reported (25, 37, 38). Several studies have reported an opposite association, finding lower mortality for those with one or more births at relatively old ages (26, 29, 39–42), although a few studies point in the other direction (43, 44).

Studies that include both women and men are potentially valuable in providing insight into the relative importance of social or biologic factors underlying associations between reproductive history and later health (14). Most of the few such studies are of high-fertility populations, several with unusual characteristics (39, 45–47). Identified studies of women and men in contemporary developed-country populations are based on surveys, not always nationally representative, subject to varying degrees of nonresponse (24, 25, 39). Recent analysis of data on the mothers and fathers of children included in a long-term British cohort reported that these parents had lower mortality than the general population of the same age (39). Another British study of people in early old age found that women with four or more children had raised odds of poor health and disability and some suggestion of a similar effect for men (25).

In this study, we used register data for a national population to analyze associations between reproductive history and mortality at ages 45–68 years among both women and men. The aims of the study were to determine whether parity was associated with later mortality risk, taking account of marital status and education and, among parents, also timing of maternity or paternity. Additionally, we wanted to investigate associations between timing of childbearing and later mortality risk in their own right and, in a subanalysis, determine whether such effects were modified by controlling for the educational level of subjects’ own parents.

MATERIALS AND METHODS

Data

Norwegian data on population and vital events are combined in a Central Population Register that was established by drawing on the 1960 census. Official personal identification numbers were allocated to the whole population then living in Norway and have subsequently been allocated at birth (or immigration). These numbers are required in all dealings with official agencies, including educational, health, housing, welfare, and tax authorities, and many commercial ones, such as banks. Another register includes level of education (48). Use of personal identification numbers allows linkage between these registers, which have been widely used in epidemiologic and demographic research (9–11, 34).

In this study, we included all men and women born in 1935–1958 and living in Norway in 1960 or at any subsequent point who therefore have a personal identification number. For these cohorts, almost complete maternity and paternity histories can be assembled because parents’ identification numbers have been recorded at registration of all births since 1965, when those included in this analysis were aged 7–30 years, and earlier births to the oldest members of the study can be captured through linkage of parent-child information from the 1960 and 1970 censuses undertaken by Statistics Norway; further details have been reported elsewhere (49). The same method of parent-child linkage enabled identification of parental information for 81.3 percent of male and 77.1 percent of female sample members born in 1950–1958 (nearly all for whom data were missing were born before 1953). The analysis was restricted to ages older than 45 years (i.e., no earlier than 1980), when women had largely completed their childbearing, and younger than 68 years, the age of the oldest cohort at the end of follow-up in 2003. In the period considered, fewer than 5 percent of men and 3 percent of women died before age 45 years, so these survivors constitute the vast majority of their respective birth cohorts (50). Sociodemographic status was controlled by including detailed information on marital status and one’s own (and, where relevant and available, spouse’s or parents’) highest educational level. A total of 785,317 men contributed 40,071 deaths during the 7.36 million person-years of follow-up, and 744,784 women contributed 23,241 deaths and 7.20 million person-years of follow-up.

Variables and modeling strategy

Discrete-time hazard models were estimated by following standard procedures (51). In such models, a series of observations for discrete time periods (in this case, 1 year) is created for each person from a relevant starting point (in this case, January, the year the person became 45 years of age) until the event of interest (in this case, death) or censorship (at the end of follow-up in 2003 or through emigration); observations for all discrete time periods are then pooled. The observations include covariates that can be time invariant (here: sex, parity, age at first and last births) or time varying (here: age, period, marital status, educational...
qualifications). The outcome variable in our case is whether the person died within the year. Logistic regression was applied to the data to estimate how the covariates were associated with the hazard of death. After we excluded periods relating to temporary absences abroad, sex-specific models were estimated, firstly for all men and women and secondly for parents of at least one child. Models were also estimated for specific age and marital status groups. The Proc Logistic procedure in SAS software was used (SAS Institute, Inc., Cary, North Carolina).

Age at first birth and total parity may be influenced by childhood circumstances that also affect health. We partially controlled for this possibility by fitting further models adding information on the education of parents of the youngest cohorts (born in 1950–1958) included in the analysis whose mortality was observed between the ages of 45 and 53 years. After those with missing parental education data had been excluded, there were 2,105 deaths and 929,385 person-years of observation for men and 1,397 deaths and 911,179 person-years of observation for women.

Categorization of age group at first birth was sex specific based on the distribution of these ages for women and the distribution of these ages for men. Calendar year and the person’s age were included as continuous control variables in all models. A fivefold classification of one’s own and spouse’s current level of education (i.e., in the year of observation) was derived by distinguishing those with compulsory-level (10 years of schooling), lower secondary (11–12 years), higher secondary (13 years), higher (14–17 years), and postgraduate education. Parental education (most recent available) was dichotomized into compulsory versus secondary or higher because of the very small proportions with advanced-level qualifications.

In addition to including current marital status (never married, currently married, divorced or separated, widowed) as a covariate, we estimated stratified models because effects of reproductive history may be modified by marital status. The data did not allow identification of those in nonmarital cohabiting unions, which could be a source of bias because the unmarried with children are probably more likely than the unmarried childless to be cohabitating. However, in the cohorts and age groups we considered, rates of cohabitation were low. In 1993, for example, fewer than 5 percent of people aged 45–69 years, and approximately 15 percent of unmarried people of this age, were cohabiting (52).

Separate models were run for two broad age groups (45–54 and 55–68 years), in addition to including age in single years as a continuous covariate. Current age, age at last birth, and current age of the youngest child are linearly dependent on each other, and some evidence in the literature suggests that co-residence with a child has beneficial effects on health and health-related behaviors (3–8). This factor might confound associations between late age at maternity or paternity, one of the aspects of reproductive history we investigated, and mortality. We therefore wanted to determine whether associations were similar in these two broad age groups because this potential problem would be much less relevant among those aged 55–68 years than in the younger group (information on household composition was not available).

### RESULTS

Characteristics of the sample are shown in table 1. Some 63.4 percent of women and 60.6 percent of men had had two or three children, and 11.3 percent of the former and 15.9

| TABLE 1. Distribution of the sample by variables used in the analysis of reproductive history and mortality in late middle age, Norway, 1980–2003 |
|--------------------------------------|------------------|-----------------|
|                                      | All women        | All men         |
| Mean (SD*) age in years              | 52.04 (5.49)     | 51.91 (5.42)    |
| Mean (SD) age in the age group       |                  |                 |
| group 45–54 years                    | 48.98 (2.83)     | 48.97 (2.83)    |
| Mean (SD) age in the age group       | 59.00 (3.31)     | 58.91 (3.27)    |
| Mean (SD) age at first birth (%)     |                  |                 |
| ≤20 (women), ≤23 (men)              | 13.51            | 18.81           |
| 20–24 (women), 23–28 (men)          | 50.16            | 52.32           |
| ≥30 (women), ≥35 (men)              | 10.14            | 7.65            |
| Mean (SD) age in years at first birth|                  |                 |
| ≤20 (women), ≤23 (men)              | 23.80 (4.34)     | 26.71 (5.07)    |
| 20–24 (women), 23–28 (men)          | 29.50 (5.05)     | 32.68 (6.13)    |
| Last birth at age ≥39 years (%)     | 3.10             | 13.04           |
| No. of deaths                       | 19,106           | 40,071          |
| Person-years of observation         | 7,196,610        | 7,360,471       |

* SD, standard deviation; MSc*, master's degree or higher postgraduate qualification.
percent of the latter no children. Fewer than 5 percent had had five or more children. Among parents, mean ages at first and last births, respectively, were 23.8 and 29.5 years for women and 26.7 and 32.7 years for men.

Table 2 shows results from modeling odds of death for women and men by number of children borne/fathered, marital status, and education. Mortality was inversely associated with years of education and was higher for the unmarried than for the married reference group, being highest among the divorced and separated. Also consistent with the literature, marital status differentials were greater among men than women. For both women and men, odds of death were highest for the childless and next highest for those who had had only one child; in all sex and age groups, odds for both were significantly higher than for the reference category comprising parents of two children. Mortality for women with three or four children was lower than for those with two, although this difference was not statistically significant in the age group 45–54 years. High parity (five or more children) was not significantly associated with mortality among either women or men, although, among women, odds ratios were below 1.

Stratified analyses were undertaken for separate marital status groups, controlling for the same variables as above and for spouse’s educational level for those currently married. Figure 1 shows odds ratios and 95 percent confidence intervals from these (fully adjusted) models for ever-married groups. Effects were similar in all groups. Thus, childless men and women and those who had had only one child had elevated risks of mortality whether they were married, divorced or separated, or widowed. Married women with three, four, or five or more children had a significantly lower mortality rate than fathers of two children; formerly married men who had had five or more children also had a lower mortality rate than fathers of two children. In no instance was higher parity significantly associated with higher mortality risk. Results for the never married are not shown in figure 1 because of the very different distribution by parity. Most never-married men and women were nulliparous (81.9 percent and 71.3 percent, respectively), and small proportions had had more than two children (2.5 percent of men, 4.2 percent of women). Model results nevertheless showed higher mortality among the childless never married compared with never-married parents of two children (odds ratio (OR) for women = 1.59, 95 percent confidence interval (CI): 1.28, 1.98; OR for men = 1.99, 95 percent CI: 1.70, 2.32) and gave no indication of disadvantage for parents of three or more children (odds ratios below 1).

Results from models taking into account timing of maternity or paternity and excluding the nulliparous are shown in table 3. For mothers, results showed an overall negative association between parity and mortality, with mortality for mothers of five or more children being the lowest (OR = 0.88, 95 percent CI: 0.80, 0.96). For fathers, the lowest mortality was observed for those with three children and the highest mortality for those with only one. Mortality risks were raised for mothers and fathers who had had their first child in the youngest age band and tended to decrease with older age at first birth. The last birth occurring at age 40 years or older was associated with reduced mortality among fathers aged 55–68 years and mothers aged 45–54 years.

Table 4 shows results from the subanalysis of parous men and women born in 1950–1958 for whom information on their own parents’ education was available. Neither maternal nor paternal educational level was significantly associated with mortality of the parous women in this analysis (which included subjects’ own educational level). Parous men whose mothers had higher or secondary education qualifications had lower mortality than those whose mothers had lower levels of education, but the association with paternal education was in the opposite direction, with raised mortality among sons of more-educated fathers. Women who had had their first child as a teenager and men who became a father before age 23 years had higher odds of death than those who were older at first birth, even when these parental educational variables were controlled (OR for women = 1.16, 95 percent CI: 1.00, 1.33; OR for men = 1.17, 95 percent CI: 1.05, 1.29). Parents of only one child

[FIGURE 1. Mortality (odds ratios and 95% confidence intervals) among a) ever-married women and b) ever-married men, by parity and marital status, controlling for age, year, one’s own education, and, for married women, husband’s education, Norway, 1980–2003.]

had higher odds of death than parents of two children, but there were no significant differences between those of higher parities and the reference group with two children. As in the main analysis, results indicated a mortality advantage for those who had had a child at age 40 years or older.

Finally, an additional series of models was run for women regarding mortality for all causes of death other than breast cancer. In all instances, the associations reported above were still found to be statistically significant.

**DISCUSSION**

Results from this large population study including both women and men are consistent with those from other studies in suggesting later mortality disadvantages of childlessness and teenage childbearing among women; they additionally show a similar, although less strong, association between male mortality and childlessness or paternity before age 23 years and also show consistently higher mortality among both women and men who had had only one child. Higher mortality for those who became parents at young ages was still observed when we controlled for the educational level of their own parents, although this information was missing for a fifth of the sample included in this subanalysis, and we lacked information on other aspects of the childhood environment. Our results are also consistent with some other studies in showing an association between having a child at age 40 years or older and lower mortality risk.

It must be recognized that these findings demonstrate associations rather than causality. We included detailed information on educational level in all models because it is known that education is strongly associated with fertility and mortality, but we were unable to account for other potential confounders, such as religious orientation or rural residence, that may be associated with both mortality risk and fertility. We also lacked information on quality of relationships between parents and adult children or, importantly, on prior health status and health-related behaviors. It is known that the experience of a disrupted and disadvantaged childhood is associated with risky health-related behaviors and poor health as well as with young entry to parenthood.

### TABLE 3. Odds ratios and 95% confidence intervals from fully adjusted discrete-time models of associations between number of children and timing of parenthood with mortality, parous women and men aged 45–68 years, Norway, 1980–2003†‡

<table>
<thead>
<tr>
<th>No. of children</th>
<th>Women (age in years)</th>
<th>Men (age in years)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>OR§</td>
<td>95% CI§</td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td></td>
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<tr>
<td>Age in years at first birth</td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;20 (women)/&lt;23 (men)</td>
<td>1.178</td>
<td>1.113, 1.248, 1.232</td>
</tr>
<tr>
<td>25–29 (women)/29–34 (men)</td>
<td>0.912</td>
<td>0.865, 0.963, 0.931</td>
</tr>
<tr>
<td>≥30 (women)/≥35 (men)</td>
<td>0.876</td>
<td>0.808, 0.949, 0.910</td>
</tr>
<tr>
<td>Last birth at age ≥40 years</td>
<td>0.794</td>
<td>0.687, 0.917, 0.929</td>
</tr>
<tr>
<td>No. of deaths</td>
<td>9,252</td>
<td>9,854</td>
</tr>
<tr>
<td>Person-years</td>
<td>4,434,985</td>
<td>1,945,522</td>
</tr>
</tbody>
</table>

* p < 0.05; **p < 0.01. † All p < 0.001 unless otherwise specified. ‡ Married, two children, and age at first birth 20–24 years (women)/23–28 years (men) were the reference categories; also includes control for educational status, year, and dummy indicator for missing education.
§ OR, odds ratio; CI, confidence interval.
¶ Not significant at p > 0.05.
eases predominate (60). Because high parity is reported to
age versus older ages, when deaths from cardiovascular dis-
for a higher proportion of deaths among those in late middle
postreproductive female mortality. Breast cancer accounts
variation between studies in associations between parity and
for timing of first birth) and similar, although less
significantly lower mortality among higher-parity mothers,
and evolutionary theories that posit a trade-off between re-
ents to limit their family size (57, 58).
otherwise restrict opportunities for parenthood, or lead par-
generally, poor health may in some cases affect fecundity,
likely to influence decisions about midlife parenthood. More
slower aging, not the least because perceived health status is
sexes, late parenthood may be a marker of better health and
pause, male potency declines with age (56), and, for both
mortality (53–55). Although men do not experience meno-
associate with raised mortality among nulliparous and high-
gram also showed, for women aged 50 years or older at
study entry, raised mortality among nulliparous and high-

g
der that included in this study, models in which age, marital
status, and socioeconomic status were controlled showed
excess risks for the nulliparous of a similar order, although
slightly lower, to our results (OR = 1.28, 95 percent CI:
1.10, 1.49). However, results also showed raised odds of
death for women with five or more children (OR = 1.25,
95 percent CI: 1.06, 1.46). An earlier Norwegian study (16)
that analyzed the mortality over a 20-year follow-up period
(1961–1981) of women included in a breast screening pro-
fer analyses for causes of death other than breast cancer,
and our results differed quite markedly from those from two
similar studies including women of very much the same age.
One of these studies (26) analyzed data from the England
and Wales Longitudinal Study, a large, nationally represen-
tative study including census and linked vital-events data.
For women aged 50–69 years whose mortality was observed
in 1980–2000, an age group and time period very similar to
that included in this study, models in which age, marital
status, and socioeconomic status were controlled showed
excess risks for the nulliparous of a similar order, although
slightly lower, to our results (OR = 1.28, 95 percent CI:
1.10, 1.49). However, results also showed raised odds of
death for women with five or more children (OR = 1.25,
95 percent CI: 1.06, 1.46). An earlier Norwegian study (16)
that analyzed the mortality over a 20-year follow-up period
(1961–1981) of women included in a breast screening pro-
gram also showed, for women aged 50 years or older at
study entry, raised mortality among nulliparous and high-
parity women (standardized mortality ratio for mothers of
five or more children = 1.07, 95 percent CI: 1.03, 1.12).

TABLE 4. Odds ratios and 95% confidence intervals from fully adjusted discrete-time models of
associations between number of children and timing of parenthood with mortality among parents born in
1950–1958, controlling for educational level of subjects’ parents as well as one's own education and marital
status, Norway, 1980–2003†,‡

<table>
<thead>
<tr>
<th></th>
<th>Women</th>
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<th>Men</th>
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<tbody>
<tr>
<td></td>
<td>OR§</td>
<td>95% CI§</td>
<td>OR</td>
<td>95% CI</td>
</tr>
<tr>
<td>Age</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parental education</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mother: secondary/higher</td>
<td>0.994†</td>
<td>0.879, 1.123</td>
<td>0.844</td>
<td>0.763, 0.933</td>
</tr>
<tr>
<td>Father: secondary/higher</td>
<td>1.030†</td>
<td>0.917, 1.157</td>
<td>1.142**</td>
<td>1.040, 1.255</td>
</tr>
<tr>
<td>No. of children</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>1.671</td>
<td>1.457, 1.916</td>
<td>1.370</td>
<td>1.233, 1.545</td>
</tr>
<tr>
<td>3</td>
<td>1.042†</td>
<td>0.911, 1.191</td>
<td>0.912†</td>
<td>0.814, 1.020</td>
</tr>
<tr>
<td>4</td>
<td>0.933†</td>
<td>0.733, 1.118</td>
<td>1.084†</td>
<td>0.911, 1.290</td>
</tr>
<tr>
<td>≥5</td>
<td>1.266†</td>
<td>0.867, 1.850</td>
<td>0.987†</td>
<td>0.725, 1.344</td>
</tr>
<tr>
<td>Age at first birth &lt;20 (women)/ &lt;23 (men) years</td>
<td>1.155*</td>
<td>1.005, 1.328</td>
<td>1.168**</td>
<td>1.054, 1.293</td>
</tr>
<tr>
<td>Last birth at age ≥40 years</td>
<td>0.852†</td>
<td>0.622, 1.167</td>
<td>0.708</td>
<td>0.613, 0.816</td>
</tr>
<tr>
<td>No. of deaths</td>
<td>1,397</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Person-years</td>
<td>911,179</td>
<td></td>
<td>929,385</td>
<td></td>
</tr>
</tbody>
</table>

* p < 0.05; **p < 0.01.
† All p < 0.001 unless otherwise specified.
‡ Compulsory (parental) education, two children, and age at first birth >19 (women)/>22 (men) years were the
reference categories; also includes control for marital status, one's own educational status, year, and dummy
indicator for one's own missing education.
§ OR, odds ratio; CI, confidence interval.
¶ Not significant at p > 0.05.
These differences in results might reflect to some extent confounding by factors not controlled for in any of these analyses. Differences in period and cohort, and between countries, may also be relevant. It seems plausible, for example, that larger proportions of higher-order births were planned in the more recent cohorts we considered than in the earlier Norwegian study because of differences in the availability of contraception and legal abortion. There may also be some differences between our population and the one in the England and Wales analysis in this regard. When births are planned, the argument that only the healthier have many children becomes more relevant; moreover, unplanned childbearing may itself sometimes have negative consequences for psychosocial health (61). Additionally, in the contemporary Norwegian setting, the social benefits of having many children may outweigh the (physiologic or socioeconomic) penalties.

The Nordic countries are special in that they have a very generous welfare system; child allowances are relatively large, and, during the 1980s and 1990s, there were significant extensions in paid maternity (and paternity) leave, improved access to subsidized day care, and implementation of various workplace reforms, all of which helped parents, particularly mothers, to combine paid work and family roles (62). It has been suggested that these supports explain why differentials in the health status of lone mothers and married mothers are lower in Norway than in Canada (63). Those in our study would have benefited from these developments to a greater extent than those in the earlier Norwegian analysis and had advantages in comparison to the women in England and Wales, where family supports in the period considered were less generous (64). Possibly, the mechanisms underlying the associations reported here.

The similarity of our results for women and men suggests biosocial pathways underlying associations between reproductive history and mortality that are conditioned by such contextual factors, implying that “family friendly” policies may have long-term health benefits for the parents.

The similarity of our results for women and men suggests biosocial pathways underlying associations between reproductive history and health. These pathways may include, for example, accumulated advantages of differences in health-related behaviors and social participation, as suggested by studies that have found higher rates of smoking and alcohol abuse among childless and low-parity individuals and higher rates of community activity among parents (8, 17, 31), and beneficial effects of support from adult children later in life (14–17). Research using data sets that include information on health-related behaviors and health status throughout the life course would help to clarify mechanisms underlying the associations reported here.

REFERENCES