# Validity of self-reported number of pregnancies and maternal age at first birth among females attending organized mammographic screening

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# Abstract

**Aims**: Reproductive history conveys information about potential health risks later in adulthood. This study aimed to examine the validity of self-reported number of pregnancies and maternal age at first birth (AFB) among females attending BreastScreen Norway.

**Methods**: Participants were identified through the Janus Serum Bank cohort in Norway and were eligible for this cross-sectional validation study if they participated in a health survey issued by BreastScreen Norway during 2006–2015. Retrospective, self-reported survey information on number of pregnancies and AFB in years was validated against prospectively collected information from the Medical Birth Registry of Norway (MBRN) using the spearman rank ($r_s$) and intraclass correlation coefficients (ICC) with 95% confidence intervals (CI).

**Results**: After exclusions, 51,598 subjects were included in the analysis on number of pregnancies and 46,919 in the analysis on AFB. On average, study subjects were 59–60 years old when completing the health survey and had become first-time mothers roughly 36 years earlier. Survey-based information about number of pregnancies was highly correlated and demonstrated high agreement with the registry data ($r_s$=0.967, 95%CI: 0.964–0.969; ICC=0.884, 95%CI: 0.882–0.885). Survey-based information about AFB demonstrated even higher correlation and very high agreement with the registry data ($r_s$=0.975, 95%CI: 0.973–0.976; ICC=0.974, 95%CI: 0.974–0.975).

**Conclusions**: Retrospectively recalled survey-based information about number of pregnancies and AFB was highly accurate when validated against prospectively collected information in the MBRN. These survey-based data are valuable for future epidemiological research and linkage to the MBRN may not be required when these data are available.

**Word count:** 1198

**Abbreviations**

| | |
|---|---|
| AFB | Age at first birth |
| CI | Confidence Interval |
| ICC | Intraclass correlation coefficient |
| IQR | Interquartile range |
| JSB | Janus Serum Bank |
| LOA | Limits of agreement |
| MBRN | Medical Birth Registry of Norway |

# Main text

## Background

Number of complete (parity) and/or incomplete pregnancies (gravidity) and maternal age at first birth (AFB) can convey information about potential disease risks later in adulthood, such as breast and ovarian cancer.[1-5] Although some longitudinal studies prospectively collect information on reproductive history, many studies evaluating long-term outcomes use self-reported (retrospectively recalled) data. Even when prospectively collected data about number of pregnancies and AFB are available through population-based registries, accessing these high-quality data can be time consuming and costly.

This study aimed to examine the validity of self-reported number of pregnancies and AFB among participants in a health survey issued by BreastScreen Norway. This work extends previous research on the validity and reliability of self-reported health indicators among those attending organized screening.[6]

## Methods

### Data sources

#### *Janus Serum Bank*

Eligible participants for this study were identified through the Janus Serum Bank (JSB) in Norway. The JSB cohort consists of 318,628 individuals who donated blood samples during 1972–2004.[7,8] The 152,491 females in the JSB cohort were deterministically linked to information from a health survey conducted through BreastScreen Norway and from the Medical Birth Registry of Norway (MBRN) using the national identify number assigned to people with legal residence in Norway.

#### *BreastScreen Norway health survey*

BreastScreen Norway is a population-based breast cancer screening program targeting females aged 50–69 years for ten rounds of biennial mammographic screening. Roughly 94% of those invited attend the program at least once.[9,10] Between August 2006 and December 2015 (inclusive), BreastScreen Norway issued a brief (2 page) health survey to collect self-reported information about highest obtained education, number of pregnancies that ended after ≥6 months gestation, age at first pregnancy of duration ≥6 months, and other health indicators.[11] The survey was sent alongside invitations to screening with a request to return completed questionnaires at the screening appointment; the completion rate was 53%.[11] The questionnaire is available online.[12,13]

*Medical Birth Registry of Norway*

The MBRN was established in 1967 and provided information about number of pregnancies and AFB for all pregnancies from 16 weeks of gestation (1967–2002) or 12 weeks of gestation (2002–present).[14,15] Number of pregnancies in the MBRN reflected the highest value of the mothers' self-reported number of pregnancies or that registered through routine prenatal care. Reporting to the MBRN is mandated by law for health personnel providing prenatal care or care during labour and the data are highly complete.[15,16] Maternal ages <17 or >45 years in the database were recorded as 17 or 45 for this project.

Although number of pregnancies was counted from 6 months (roughly 26 weeks) in the survey data and from 12 or 16 weeks in the registry data, for simplicity we refer to number of pregnancies as gravidity hereafter.

## Study sample

We included females in the JSB cohort who participated in the BreastScreen Norway health survey and excluded those missing data about the outcome of interest (gravidity or AFB). Data could be missing due to nulligravidity, lack of self-report, or because the participant did not give birth after the MBRN was established.

## Statistical analyses

The characteristics of study subjects were summarized using means and standard deviations (sd), medians and ranges or interquartile ranges (IQR), or frequencies and proportions, as appropriate.

Correlation between the survey and registry data for gravidity and AFB was assessed using the Spearman rank correlation coefficient ($r_s$) and 95% bootstrap percentile confidence intervals (CI) based on 10,000 repetitions. Agreement was assessed using the intraclass correlation coefficient (ICC) and 95% CI based on a single measurement, one-way random effects model.[17] Scatterplots and Bland-Altman plots were used for data visualization; the latter was also used to quantify the bias and 95% upper and lower limits of agreement (LOA) in the survey data.[18]

Data linkage was performed in Stata (version 18.0) and analyses in R (version 4.1.3). The bootstrap percentile CIs and ICCs with corresponding CIs were estimated using the *boot* and *irr* packages.[19,20]

## Ethical considerations

This study is part of the Project for Breast Cancer Risk Prediction approved by the Regional Committee for Medical Research Ethics South-East Norway (project no. 237347). The requirement for informed consent was waived.

# Results

70,179 females in the JSB cohort participated in BreastScreen Norway health survey. After exclusions, data from 51,598 subjects were included in the analysis pertaining to gravidity and 46,919 in the analysis pertaining to AFB (**Figure 1**); 21,632 subjects were included in both analyses.

The characteristics of both samples were similar: most were born during 1946–1950 and had a mean age of 59–60 years when they completed the health survey (**Table 1**). The median time between first pregnancy recorded in the MBRN data and survey completion was roughly 36 years.

## Gravidity

The mean gravidity was 2.51 and 2.48 for the survey- and registry-based data, respectively (**Table 1**). The two data sources were highly correlated ($r_s$=0.967, 95%CI: 0.964–0.969) and demonstrated good agreement (ICC=0.884, 95%CI: 0.882–0.885). Survey-based values were somewhat higher than registry-based values (**Figure 2A**), and the difference between survey- and registry-based values increased with increasing gravidity (**Figure 2B**). The estimated bias was 0.024, with 95%LOA of -0.928 to 0.976, indicating that the estimated difference between survey- and registry-based gravidity was ±1 pregnancy for 95% of individuals.

## Maternal age at first birth

The mean AFB was 24 years for both data sources (**Table 1**). The survey and registry data were highly correlated ($r_s$=0.975, 95%CI: 0.973–0.976) and demonstrated excellent agreement (ICC=0.974, 95%CI: 0.974–0.975). AFB was 30 years higher in the health survey than in the MBRN for three individuals (**Figure 2C**), and the Bland-Altman plot showed a slight trend for a higher values of AFB from the health survey with increasing AFB (**Figure 2D**). Overall, however, the bias was -0.301 years with 95%LOA of -2.08 to 1.48, indicating that survey-based AFB was within 2 years lower to 1.5 years higher than that recorded in the MBRN for 95% of individuals. Removing the three aforementioned outliers had a negligible effect on the results.

# Discussion

This cohort study assessed the validity of self-reported gravidity and AFB among females participating in the JSB and BreastScreen Norway health survey. The retrospective, self-reported information about gravidity and AFB captured through a brief BreastScreen Norway survey had very high agreement with prospectively collected data from the MBRN.

The survey data were intended to reflect information about pregnancies from 6 months gestation, while the MBRN data reflected pregnancies from 16 weeks (or from 12 starting in

2002). Despite these differences, survey-based data about gravidity were within ±1 pregnancies and AFB within ±2 years of that recorded in the MBRN for 95% of our study samples.

A strength of this study was the deterministic linkage of the survey and MBRN data. Although our samples of JSB cohort participants represented only ~12% of all those who completed the BreastScreen Norway health survey, the variables we analyzed represented a wide range of values and we assume the validity of survey data from JSB cohort members is representative for those outside the cohort.

In conclusion, the results from our study indicate that self-reported information about gravidity and AFB from the BreastScreen Norway health survey is highly accurate when validated against prospectively collected information in the MBRN. This survey-based data is therefore useful for most epidemiological studies.

## Funding statement

## Declaration of conflicting interests

The authors declare no conflicts of interest.

## Data availability

The data underlying this article cannot be shared publicly due to patient privacy. The data can be shared for research purposes on request to the Cancer Registry of Norway's data delivery unit via Helsedata.no (https://helsedata.no/). Access is conditional on adherence to local ethical and security policies. The code used to conduct specific analyses is available from the authors upon request.

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**Table 1:** Demographic and reproductive history characteristics for study subjects, stratified by analysis sample. Results presented as frequency (%), unless otherwise indicated.

| | Gravidity sample<br>n = 51,598 | Maternal age at first birth sample<br>n = 46,919 |
|---|---|---|
| **Demographic characteristics** | | |
| **Birth year** | | |
| Median [Range] | 1948 [1937, 1966] | 1948 [1937, 1966] |
| Not available | 20 (<0.001%) | 21 (<0.001%) |
| **Age at health survey completion** | | |
| Mean (sd) | 59.8 (3.7) | 59.2 (3.3) |
| Not available | 20 (<0.001%) | 21 (<0.001%) |
| **Highest education** | | |
| Highschool at most | 36,560 (70.9%) | 32,460 (69.2%) |
| Post-secondary, ≤4y | 9357 (18.1%) | 8989 (19.2%) |
| Post-secondary, >4y | 4969 (9.6%) | 4810 (10.2%) |
| Not available | 712 (1.4%) | 660 (1.4%) |
| **Region of residence*** | | |
| Oslo and Viken | 10,133 (19.6%) | 9292 (19.8%) |
| Innlandet | 9195 (17.8%) | 7891 (16.8%) |
| Agder and South Eastern Norway | 8181 (15.9%) | 7919 (16.9%) |
| Western Norway | 8709 (16.9%) | 8066 (17.2%) |
| Trøndelag | 5458 (10.6%) | 4879 (10.4%) |
| Northern Norway | 6932 (13.4%) | 6132 (13.1%) |
| Not available | 2990 (5.8%) | 2740 (5.8%) |
| **Reproductive history** | | |
| **Years from first registry-reported pregnancy to health survey completion** | | |
| Median [IQR] | 37 [34, 40] | 36 [33, 39] |
| Not available | 1573 (3.0%) | 21 (<0.001%) |
| **Gravidity – health survey** | | |
| Mean (sd) | 2.51 (1.05) | 2.40 (0.99) |
| Median [IQR] | 2 [2, 3] | 2 [2, 3] |
| Range | [1, 18] | [1, 18] |
| Not available | - | 5114 (10.9%) |
| **Gravidity – Medical Birth Registry** | | |
| Mean (sd) | 2.48 (0.96) | 2.35 (0.90) |
| Median [IQR] | 2 [2, 3] | 2 [2, 3] |
| Range | [1,10] | [1,10] |
| Not available | - | - |
| **Age at first birth – health survey** | | |
| Mean (sd) | 23.2 (4.3) | 23.9 (4.2) |
| Median [IQR] | 23 [20, 25] | 23 [21, 26] |
| Range | [13, 49] | [13, 49] |
| Not available | 1553 (3.0%) | - |
| **Age at first birth – Medical Birth Registry** | | |
| Mean (sd) | 24.1 (4.2)** | 24.2 (4.2) |
| Median [IQR] | 23 [21, 26]** | 23 [21, 26] |
| Range | [17, 45]** | [18, 44] |
| Not available | 8067 (15.6%) | - |

*Region of residence at entry into Janus Serum Bank Cohort
**includes 487 cases (0.9%) recorded as 17 or 45 by the Medical Birth Registry of Norway, but that represent ages ≤17 or ≥45
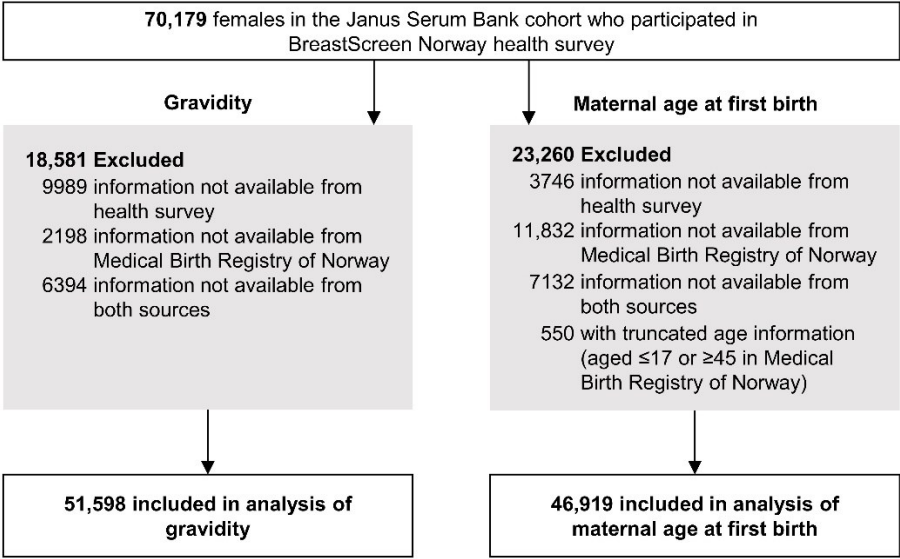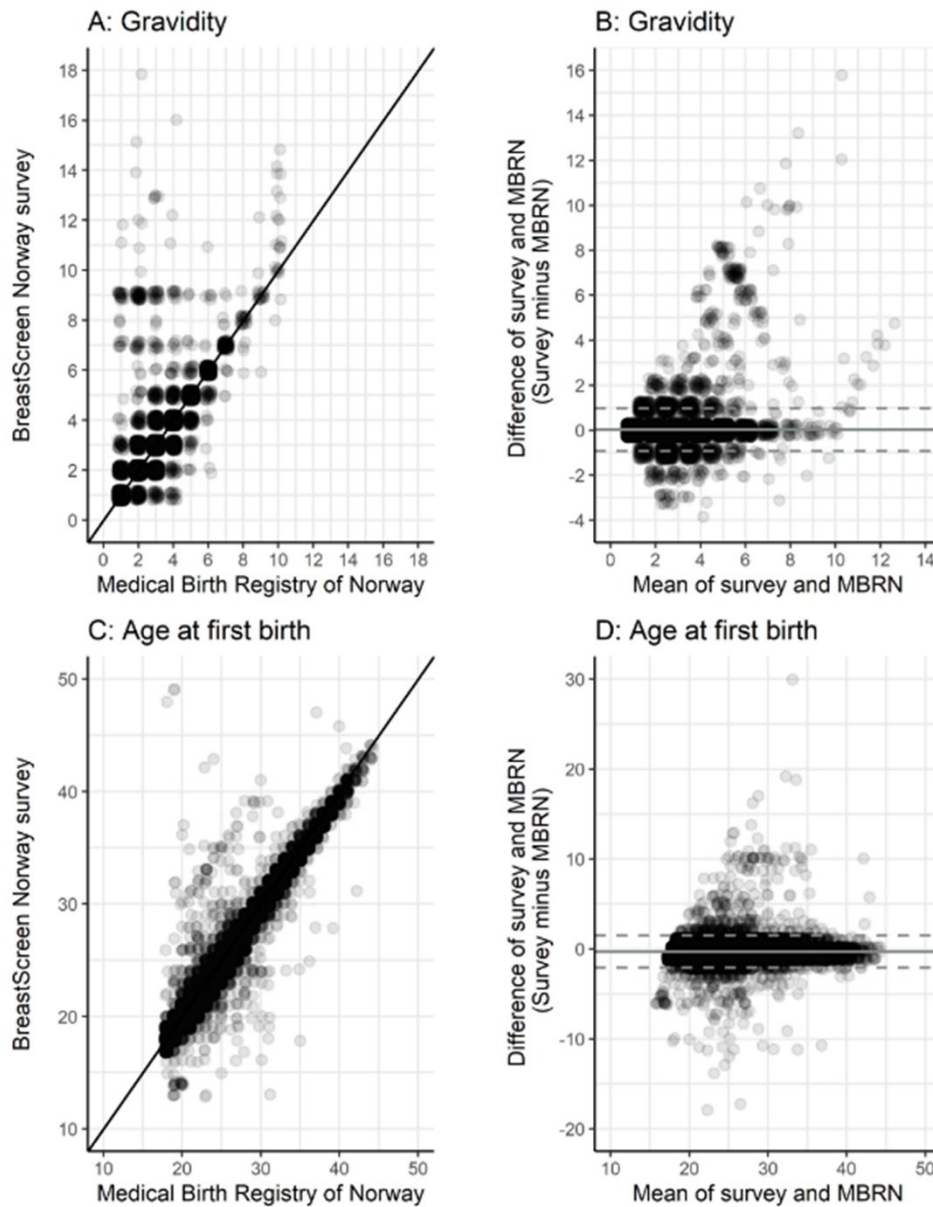
Figures



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┌─────────────────────────────────────────────────────────────┐
│  70,179 females in the Janus Serum Bank cohort who participated in │
│            BreastScreen Norway health survey                 │
└─────────────────────────────────────────────────────────────┘
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**Gravidity**                    **Maternal age at first birth**

**18,581 Excluded**
  9989 information not available from
      health survey
  2198 information not available from
      Medical Birth Registry of Norway
  6394 information not available from
      both sources

**23,260 Excluded**
  3746 information not available from
      health survey
11,832 information not available from
      Medical Birth Registry of Norway
  7132 information not available from
      both sources
   550 with truncated age information
      (aged ≤17 or ≥45 in Medical
      Birth Registry of Norway)

**51,598 included in analysis of gravidity**

**46,919 included in analysis of maternal age at first birth**

**Figure 1**: Flowchart showing inclusion and exclusion criteria for analyses in this study.

**Figure 2:** Relationship between survey data and the Medical Birth Registry of Norway (MBRN) presented in a **(A)** scatterplot for gravidity, **(B)** Bland-Altman plot for gravidity, **(C)** scatterplot for age at first birth, **(B)** Bland-Altman plot for age at first birth. The Bland-Altman plots show the mean value per subject (x-axis) against the difference between the survey-based and registry-based values (y-axis). The solid line in the Bland-Altman plots indicates the mean difference (bias) between the two sources, while the upper and lower dashed lines indicate the upper and lower 95% limits of agreement. A small amount of random noise has been added to the observations in all plots.