Utilisation of Prenatal Diagnostics During Pregnancy in Germany: Cross-sectional Study Using Data From the KUNO Kids Health Study

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Abstract

Background: Appropriate health system utilisation during pregnancy is fundamental for maintaining maternal and child's health. This study provides comprehensive data on supplementary prenatal diagnostics use and its influencing factors in Germany.

Methods: We obtained data from a recently established prospective German birth cohort study, the KUNO Kids Health Study, with a study sample of 1886 participating mothers. Analyses are based on Andersen's Behavioural Model of health system use, which distinguishes between predisposing, enabling and need factors. We examined bi- and multivariate association with the use of supplementary prenatal diagnostics using logistic regression.

Results: One fifth of the mothers investigated did not use any supplementary prenatal diagnostics. Notably, the chance of using supplementary prenatal diagnostics more than doubled if the pregnant woman had a private health insurance. Higher maternal age and environmental tobacco smoke exposure increased the use of supplementary prenatal diagnostics. However, regarding need factors only having a risk-pregnancy showed an independent association.

Conclusion: Although a shift in the importance of need factors towards enabling factors for preventive health services has been described before, the important role of the type of health insurance and the relatively small influence of need factors was surprising and worrisome. Especially with respect to equity in accessing health care, this needs further attention.

Background

Medical-technical progress of recent years has contributed to an improvement in prenatal care (1). Inadequate or insufficient use of antenatal care is seen as a main risk factor for adverse pregnancy outcomes (3, 4). Appropriate health system utilisation during pregnancy allows providing information about prevention programmes and to ensure that adequate therapy is initiated in case of pregnancy-specific or concurrent diseases (2). On the other hand, a further increase in screening programmes and additional examinations burdens health systems due to an increase in costs (2). Hence, appropriate health system utilisation during pregnancy is fundamental, thereby maintaining maternal and child's health(5) as well as a cost-effective health care system.

Prenatal diagnostics has gained importance in recent years (6). According to a study by the Federal centre of Health education in Germany only 15% of women stated that they did not use any prenatal diagnostic examination (7). A more detailed consideration reveals a decrease of invasive prenatal diagnostics in favour of an increase in non-invasive prenatal diagnostics in recent years (6). The further development of non-invasive methods, such as the analysis of cell-free DNA from maternal blood, may lead to a further increase in prenatal diagnostics use (6, 8).

An established model to describe health services use is the Behavioural Model of Health Services Use developed by R.M. Andersen (9), which has been revised several times (10, 11). The advantage of the model is, that it considers a wide range of determinants of health system use (12, 13). Andersen defined three primary determinants of health care use: Predisposing factors including demographic characteristics such as age or ethnicity, enabling resources such as health insurance and subjectively as well as objectively surveyed need factors. Furthermore the model distinguishes between individual factors and contextual characteristics (such as accessibility of health services) (11). For better understanding the model is illustrated in Fig. 1.

Even though this framework is frequently applied to investigate health system use (9), only a few studies have so far considered the period of pregnancy (14). Among those, most researchers analysed timing or content of antenatal care (2, 15–18). Earlier German studies solely focused on a single predictor of health care utilisation during pregnancy, such as migration (19–21) or physical activity (22). However, to the best of our knowledge, studies using Andersen's model to describe the use of medically indicated and non-medically necessary prenatal diagnostic examinations beyond the regular preventive examinations during pregnancy in Germany are lacking.

We addressed this research gap using data from a recently established prospective birth cohort study, the KUNO Kids health study, to provide current data on the utilisation of supplementary prenatal diagnostics in Germany as well as to identify influencing factors. Analyses are based on Andersen's Behavioural Model of Health System Use (11).

Materials And Methods

We obtained data from a prospective birth cohort study, the KUNO Kids Health Study, initiated at St. Hedwig hospital in Regensburg in Eastern Bavaria. The study aims to investigate a wide range of potential factors influencing various health-related outcomes in an interdisciplinary manner. Study design and procedures are described in more detail elsewhere (23).

St. Hedwig hospital is a level 1 perinatal centre with over 3 000 births per year and about two thirds of the children in the region are born there (23). The catchment area includes the city of Regensburg with 164 000 inhabitants and the surrounding rural regions and is characterised by one of the lowest unemployment rates in Germany as well as rising population figures (24). 2657 infants and their families have joined the study between 27th June 2015 and 28th June 2018.

All mothers who gave birth at St. Hedwig hospital in Regensburg were asked within 48 hours after delivery for voluntary participation. Written informed consent was obtained. Criteria for exclusion were insufficient German language skills and maternal age less than 18 years. The study has been approved by the Ethics Committee of the University of Regensburg (file number: 14-101-0347).

Data collection

Information about maternal health system utilisation during pregnancy and influencing factors was collected retrospectively through a standardised interview and self-administered questionnaires. The interview was conducted by study team members during the hospital stay after delivery. Immediately after the interview the baseline questionnaire was handed out to the mother and completed independently. Study team members rated maternal German language skills after the interview. Information about maternal age was taken directly from the electronic hospital chart.

Predictor variables

Variables were characterised as predisposing, enabling and need factors according to the Andersen model. Table 1 provides an overview of the grouping of the predictor variables.

Table 1
Predictor variables

Predisposing Factors	Enabling Factors	Need Factors
Maternal age	Health insurance	Risk-pregnancy
Primiparous/multiparous	Travel time to obstetrician	Complications during pregnancy
Single parenting	Health literacy	Pre-existing illness
Country of birth other than Germany	Social support	
German language skills		
Education level		
No employment before maternity leave		
Smoking behaviour		
Physical activity in the year before pregnancy		
Unhealthy diet		

Predisposing factors

Predisposing factors included maternal age (years), parity (primi-/multiparous), single-parenting (yes/no), country of birth (Germany/other than Germany), German language skills (excellent/lack of excellent German language skills), educational attainment (more than 10 years, 10 years, less than 10 years), employment before maternity leave (yes/no), smokers living in the household (yes/no), physical activity in the year before pregnancy (no/less than one hour per week/1–2 hours per week/ more than 2 hours per week), unhealthy diet (yes/no). Unhealthy diet was defined as fruit or vegetable consumption less than once a day.

Enabling factors

Enabling factors considered the type of health insurance (private/statutory), traveling time to obstetrician (less than 15 minutes, 15 to 30 minutes, 30 to 60 minutes, more than 60 minutes), health literacy (see definition below) and social support (see definition below).

Health literacy is characterised as the ability to understand health related information concerning treatment options and health conditions, to know where to seek for care as well as the ability to take one's medication correctly and being able to make appropriate health decisions (25, 26). We assessed maternal health literacy with the health care scale of the European Health Literacy Survey (HLS-EU-Q47). Questions concerning health literacy were part of the interview. The answers (ranging from very difficult to very easy) are rated on a four-point Likert scale and coded with 0 for very difficult or difficult and 1 for easy or very easy. The sum of the items leads to a score, whereas a higher score level is associated with higher health literacy (27).

We used the short version of the social support questionnaire (F-SozU K-14) in order to assess the level of perceived social support. The questions of the F-SozU K-14 were part of the baseline questionnaire. A total score was derived by the sum of all items (coded from 1 to 5) divided by the number of items, with higher values indicating a higher level of perceived social support (28).

Need factors

Concerning need factors having a risk-pregnancy (yes/no), having hypertension or diabetes during pregnancy (yes/no), having preterm contractions, jaundice or HELLP (Hypertension, Elevated Liver enzymes and Low Platelets) (yes/no) as well as pre-existing illnesses (yes/no) was regarded. All these questions (including whether it was a risk-pregnancy or not) were answered by the mother in the interview. Regarding the variable risk-pregnancy, it refers to the definition of the maternity guideline catalogue, respectively the entry in the maternal routine care document (so called "Mutterpass"). Although the mother was informed about the criteria, risk-pregnancy was assessed by self-report and not medically verified.

Outcome

Supplementary prenatal diagnostics was specified as the use of at least one medically indicated or non-medically necessary prenatal diagnostic examination beyond the regular preventive examinations during pregnancy. The following procedures have been included in the interview (Table 2): fetal anomaly screening, amniocenteses, first trimester screening, 3D or 4D ultrasound, cordocentesis, translucency measurement, chorionic villus sampling or non-invasive prenatal testing of maternal blood.

Table 2
Outcome variable

Supplementary prenatal diagnostics
Fetal anomaly screening
3D or 4D ultrasound
Amniocenteses
Cordocentesis
Chorionic villus sampling first trimester screening
Non-invasive prenatal testing of maternal blood
Translucency measurement

Statistical analyses

The study sample is defined as all mothers who participated in the interview and answered the baseline questionnaire between 27th June 2015 and 28th June 2018. After excluding cases with missing values on the analytical variables, 1886 cases were left for analyses (Fig. 2).

We conducted statistical analyses using IBM SPSS statistics 24 (29). In a first step we performed descriptive analysis to describe the study population. Associations between predictor and outcome variables were calculated using univariable logistic regression. In a second step, we performed multivariable predictive regression analyses to quantify the independent effect of each single variable. All variables with a p-value smaller than 0.2 in univariable analysis were included in the multivariable model. Odds ratios (OR) with 95% confidence intervals (CIs) were computed.

Results

Mean maternal age at delivery was 34 years, less than half of all mothers were multiparous. Twelve percent were born outside Germany and in 21 % of all families, smokers were living in the household. 36% were physically inactive in the year before pregnancy and 15% had a private health insurance. As the clinic St. Hedwig is tertiary perinatal centre the number of risk pregnancies was relatively high (42%), as was the proportion of women having a pre-existing illness (65%). One fifth did not use any supplementary prenatal diagnostics.

Further characteristics of the study population are shown in Table 3.

Table 3
Characteristics of the study population

Predisposing factors	**Mean**	**SD**	**Min / Max**
Maternal age (years)	34.33	4.463	19 / 49
	N		**(%)**
Multiparous	847		45.2
Single parenting	44		2.4
Country of birth other than Germany	226		12.2
No excellent German language skills	94		5.7
Educational attainment			
Less than 10 years of education	26		1.4
10 years of education	716		39.3
More than 10 years of education	1082		59.3
No employment before maternity leave	207		11.2
Smokers living in the household	397		21.4
Physical activity in the year before pregnancy			
No physical activity	669		35.8
Less than 1 hour per week	204		10.9
1–2 hours per week	476		25.5
More than 2 hours per week	519		27.8
Unhealthy diet	870		47.1
Enabling factors			
Private health insurance	278		15
Travel time to obstetrician			
< 15 min.	635		34.3
15–30 min.	839		45.3
30–60 min.	348		18.8
> 60 min.	31		1.7
	Mean	**SD**	**Min / Max**
Health literacy (European Health Literacy Survey (HLS-EU-Q47)[1]	35.62	7.317	0 / 50
Social support (short version of the social support questionnaire (F-SozU K-14)[2]	4.43	0.525	1.2/ 5.0
Need factors	**N**		**N (%)**

Predisposing factors	Mean	SD	Min / Max
Risk-pregnancy	786		42.6
Hypertension or diabetes during pregnancy	391		21.2
Preterm contractions, jaundice or HELLP	288		15.6
Pre-existing illness (diabetes mellitus type 1, diabetes mellitus type 2, liver disease, kidney disease, thyroid disease, hip dysplasia, cancer, coagulation disorder, cardiac arrhythmia, heart attack, heart failure, hypertension prior to the pregnancy, pyelonephritis, urological disease, other metabolic disease, ADHD, depression, anorexia, bulimia, migraine, anxiety or panic disorder, multiple sclerosis, peripheral facial nerve palsy, febrile seizure, epilepsy, single seizure, meningitis, encephalitis)	1192		64.5
OUTCOME	**N**		**N (%)**
Supplementary prenatal diagnostics use	1453		79.9
SD: standard deviation 1 Interview 2 Baseline questionnaire			

Univariable Analyses

In univariable analyses (Table 4), the predisposing factor maternal age indicated a higher chance of supplementary prenatal diagnostics use. No employment before maternity leave was associated with a reduced chance for using supplementary prenatal diagnostics.

Regarding enabling factors having a private health insurance showed a positive association with supplementary prenatal diagnostics use.

Concerning need factors only a reported risk-pregnancy and having a pre-existing illness indicated a higher chance for supplementary prenatal diagnostics use in the univariable model.

Table 4
Results from univariable logistic regression analyses

Variable	OR	Significance	95% CI
Predisposing factors			
Multiparous	0.911	0.426	[0.724; 1.147]
Maternal age	**1.073**	**< 0.001****	**[1.045; 1.102]**
Single parenting	1.205	0.658	[0.529; 2.746]
Country of birth other than Germany	0.995	0.976	[0.696; 1.421]
No excellent German language skills	1.308	0.371	[0.727; 2.352]
Education level (compared to < 10years)			
10 years	1.167	0.748	[0.455; 2.991]
> 10 years	1.430	0.454	[0.560; 3.649]
No employment before maternity leave	**0.691**	**0.034***	**[0.491; 0.973]**
Smokers living in the household	1.316	0.070	[0.977; 1.773]
Physical activity in the year before pregnancy (compared to no physical activity)			
<1 hour/week	1.130	0.556	[0.753; 1.695]
1–2 hours/week	1.007	0.966	[0.748; 1.355]
> 2 hours/week	1.003	0.984	[0.750; 1.341]
Unhealthy diet	0.966	0.772	[0.767; 1.218]
Enabling factors			
Private health insurance	**2.498**	**< 0.001****	**[1.659; 3.761]**
Travel time to obstetrician (compared to < 15 min.)			
15–30 min.	1.073	0.595	[0.827; 1.394]
30–60 min.	1.194	0.309	[0.849; 1.679]
> 60 min.	1.634	0.370	[0.558. 4.780]
Health literacy	1.013	0.109	[0.997; 1.029]
Social support	0.882	0.288	[0.700; 1.112]
Need factors			
Risk-pregnancy	**1.944**	**< 0.001****	**[1.519; 2.489]**
Hypertension or diabetes	1.025	0.869	[0.768; 1.368]
Preterm contractions, jaundice or HELLP	1.034	0.839	[0.750; 1.425]
Pre-existing illness	**1.313**	**0.025***	**[1.036; 1.665]**

OR: Odds Ratio, p: P-value, 95% CI: 95% confidence interval

Multivariable Analyses

The chance of using supplementary prenatal diagnostics (Table 5) increased significantly with increasing maternal age and was also significantly increased when smokers were living in the household However, being unemployed before maternity leave did not remain significant in the multivariable model. For enabling characteristics, the chance of using supplementary prenatal diagnostics more than doubled if the mothers had a private health insurance. Similarly, a reported risk-pregnancy significantly increased the chance of supplementary prenatal diagnostics use with respect to need characteristics. Having a pre-existing illness did not remain significant in the multivariable model (Table 5).

Table 5
Results from multivariable logistic regression analyses

Variable	OR	Significance	95% CI
Predisposing factors			
Maternal age	**1.038**	**0.018***	**[1.006; 1.071]**
Smokers living in the household	**1.465**	**0.017***	**[1.071; 2.004]**
Enabling factors			
Private health insurance	**2.336**	**< 0.001****	**[1.527; 3.573]**
Need factors			
Risk-pregnancy	**1.688**	**< 0.001****	**[1.271; 2.241]**
Pre-existing illness	1.158	0.250	[0.902; 1.486]

Discussion

The present study assessed the amount and determinants of supplementary prenatal diagnostics use. Higher maternal age and environmental tobacco smoke exposure increased the chance for the use of supplementary prenatal diagnostics. Notably having a private health insurance showed a strong association with higher odds of supplementary prenatal diagnostics. With respect to this, the chance of using supplementary prenatal diagnostics more than doubled if the mother had a private health insurance. However, regarding need factors only having a risk-pregnancy was independently associated with supplementary prenatal diagnostics use.

To the best of our knowledge, this is the first study using Andersen's model to describe supplementary prenatal diagnostics use in Germany. Earlier studies mainly focused on timing and content of antenatal care (2, 3, 15–18). Further most studies regarding prenatal diagnostics were set outside of Germany (30, 31) or did not apply Andersen's model (6). Therefore, comparability is limited. We set out to address this research gap to provide precise data about the amount and influencing factors of supplementary prenatal diagnostics use in Germany.

Predisposing factors

Higher maternal age is associated with risk pregnancies which may lead to an increased use of supplementary prenatal diagnostics, especially as further prenatal diagnostics is covered by health insurance due to risk status (33). Our findings identifying maternal age as predictor for the use of supplementary prenatal diagnostics are in line with a recent study describing maternal age as the strongest predictor for undergoing invasive prenatal care (30).

Previous studies indicate a higher chance of using supplementary prenatal diagnostics if smokers are living in the household. This may be partly explained by findings reporting a higher utilisation of medical services among smokers in general (34, 35). Even though the data of these studies did not permit an analysis of the causes, higher morbidity rates due to smoking (34) as well as a less health conscious behaviour (35) were discussed. However, our results are in contrast to previous studies reporting

smoking as risk factor for an inadequate use of antenatal care (3, 16) or lower degrees of undergoing combined ultrasound and biochemical test (30).

A possible explanation for our diverging results could be that most studies examined the association between smoking and health service utilisation. In our analyses, however, "smokers living in the household" was used as independent variable. Thus, especially in those cases where only the father is a smoker, the mother as a non-smoker could be particularly aware of the risks for the child and therefore have higher utilisation rates of supplementary prenatal diagnostic programmes. Additionally, it has to be taken into account that the awareness regarding health risks of smoking during pregnancy has increased in recent years. With respect to this, the increased use of additional prenatal diagnostics could also be seen as success of these prevention programmes.

Enabling factors

The role of private health insurance we identified is in line with previous research that reported social differences in health system utilisation in Germany (32, 47). A range of studies identified higher utilisation rates of preventive health care for higher socio-economic status groups, better educated or people with a private health insurance, whereas socially disadvantaged show increased hospitalisation rates (36–38, 39). These findings are supported by our data. There are several possible explanations. First, differences may be caused due to different information status about health care services or health in general. This may contribute especially to the lack in the use of preventive care (40). A further explanation may be Andersen's hypothesis that the use of elective health services is mainly explained by enabling resources whereas for the use of hospitals need factors are more important, as they are mainly consulted due to more serious problems (11, 41).

The above-mentioned findings are according to our analyses concerning educational attainment, which revealed a higher chance for the use of supplementary prenatal diagnostics with a higher educational attainment. However, the association did not remain significant in the multivariable model. This is in line with findings from the Robert Koch Institute which did not support an association between education and health care use, but strong differences according to social conditions (42).

Need factors

Most studies addressing health system utilisation reported need factors as strong factors involved (12, 14). However, regarding supplementary prenatal diagnostics only the variable "having a risk-pregnancy" showed an independent association, whereas no significant association between the other need factors and the use of supplementary prenatal diagnostics was found. The positive association between a risk-pregnancy and supplementary prenatal diagnostics use is consistent to an increase in the number of prenatal visits when risk status arose in a study of Feijen-de-Jong et al. (3). The relatively small association with need factors in general and the important role of the type of health insurance was surprising and worrisome, however it contributes to the above mentioned hypothesis by Andersen et al. (41, 43).

Frequency of utilisation of supplementary prenatal diagnostics

Regarding the frequency of use of supplementary prenatal diagnostics comparisons are limited as official statistics are lacking and most studies analysed utilisation rates for special examinations such as translucency measurement and not the total amount of supplementary prenatal diagnostics use (6). For example, the 2015 Health Monitor reported around 50% uptake of a 3/4D ultrasound (1).

Strengths and Limitations

As the St. Hedwig hospital is a tertiary perinatal centre it covers a major part of births in the region of Eastern Bavaria. However, there is a relatively high proportion of women with risk pregnancies(23) which could lead to higher health care utilisation rates during pregnancy. On the other hand, the prevalence of risk-pregnancies in the study sample is 42%, which does not differ considerably from the Bavarian average of 36% (44). A further limitation is that risk-pregnancy was assessed by self-report and not verified by a medical diagnosis.

Due to language barriers migrants are often underrepresented in population based research (23, 45). This is also a potential limitation of our study, as we excluded participants with insufficient German language skills to give informed consent. However,

the percentage of mothers having another country of birth than Germany is approximately consistent with official statistics for women in German population and for the region (46).

There is an underrepresentation of the lowest education group (47). This may be an explanation why educational level did not show a significant association to outpatient care use. Nevertheless, also findings from the Robert Koch Institute did not support an association between education and supplementary prenatal diagnostics use (42). Furthermore, women who would otherwise have been unattainable, could be included to the study due to the special efforts in recruitment.

Conclusion

The study provides comprehensive data from a large sample of mothers on the utilisation of health care during pregnancy, as well as potentially influencing factors. Especially the strong influence of the type of health insurance as well as the relatively small importance of need factors have to be taken into account and considered when discussing equity in accessing health care.

Abbreviations

HELLP (Hypertension, Elevated Liver enzymes and Low Platelets), HL: health literacy, KUNO: Kinder Uniklinik Ostbayern (children's university hospital for the region of eastern Bavaria)

Declarations

Ethics approval and consent to participate

The study has been approved by the Ethics Committee of the University of Regensburg (file number: 14-101-0347). All participating mothers provided written informed consent.

Consent for publication

Not applicable.

Availability of data and materials

The datasets used and analysed for this paper are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

JM: recruited participants in the clinic, analysed and interpreted the data, prepared and edited the manuscript.

SB: analysed and interpreted the data, critically revised the manuscript.

CT: critically revised the manuscript.

BSG: conceptualized the design of the study and facilitated recruitment of participants in the clinic.

SFM: contributed her expertise and facilitated recruitment of participants in the clinic.

MM: contributed to the design of the study and facilitated recruitment of participants.

MK: designed the study.

CA: contributed to the design of the study, helped to interpret the data, and critically revised the manuscript.

All authors read and approved the final manuscript.

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Figures

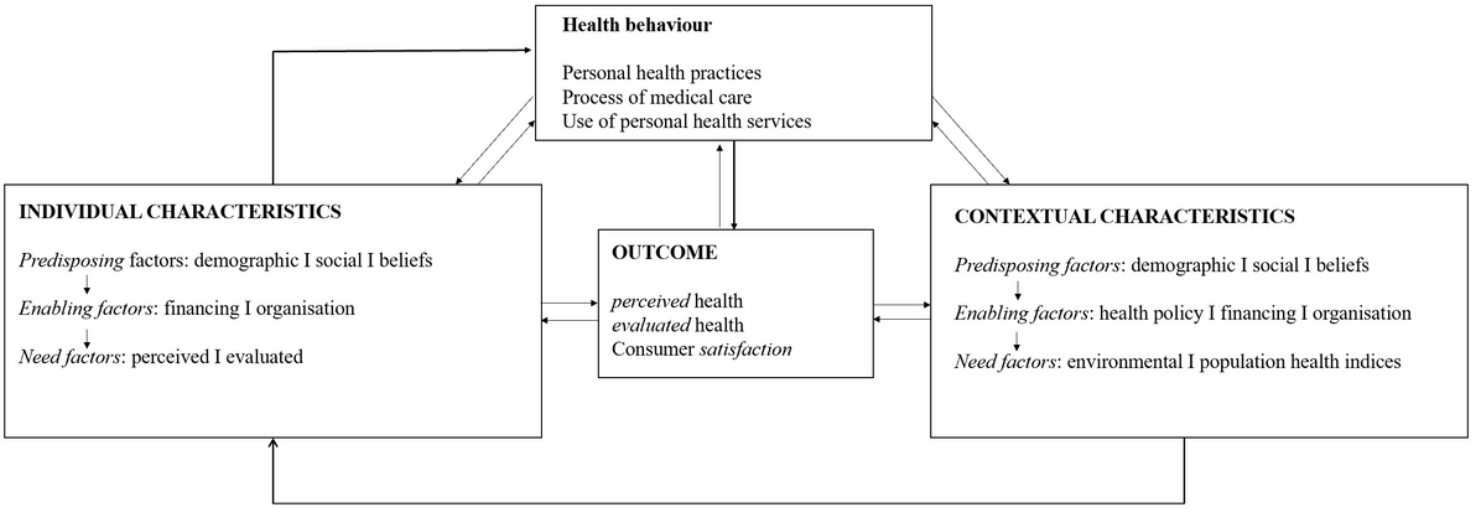

Figure 1

Behavioural model of health service use including contextual and individual characteristics, modified according to Andersen (11).

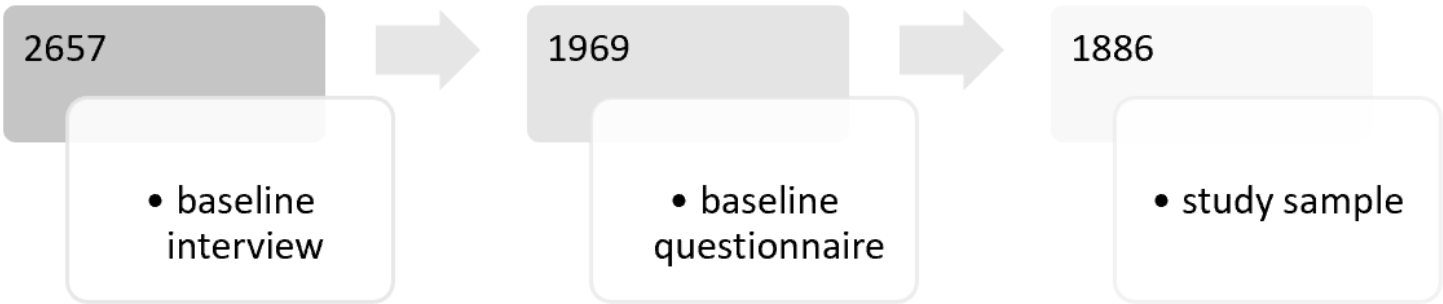

Figure 2

Study sample