Utilisation of supplementary prenatal screening and diagnostics in Germany: cross-sectional study using data from the KUNO Kids Health Study

Johanna Mayer1,2,3, Susanne Brandstetter1,4, Christina Tischer3,5, Birgit Seelbach-Göbel6, Sara Fill Malfertheiner6, Michael Melter1,4, Michael Kabesch1,4, Christian Apfelbacher2,3,4* and KUNO Kids Study group

Abstract

Background: Appropriate health system utilisation during pregnancy is fundamental for maintaining maternal and child's health. To study the use and determinants of supplementary prenatal screening and diagnostics in Germany this study provides comprehensive data.

Methods: We obtained data from a recently established prospective German birth cohort study, the KUNO Kids Health Study. Analyses are based on Andersen's Behavioural Model of health system use, which distinguishes between predisposing (e.g. country of birth), enabling (e.g. health insurance) and need factors (e.g. at-risk pregnancy). We examined bi- and multivariate association with the use of supplementary prenatal screening and diagnostics using logistic regression.

Results: The study has a sample size of 1886 participating mothers. One fifth of the mothers investigated did not use any supplementary prenatal screening or diagnostics. Notably, the chance of using supplementary prenatal screening and diagnostics more than doubled if the pregnant woman had a private health insurance (OR 2.336; 95% CI 1.527–3.573). Higher maternal age (OR 1.038; 95% CI 1.006–1.071) and environmental tobacco smoke exposure (OR 1.465 95% CI 1.071–2.004) increased the use of supplementary prenatal screening and diagnostics. However, regarding need factors only having an at-risk-pregnancy (OR 1.688; 95% CI 1.271–2.241) showed an independent association.

Conclusion: The important role of the type of health insurance and the relatively small influence of need factors was surprising. Especially with respect to equity in accessing health care, this needs further attention.

Keywords: Supplementary prenatal screening and diagnostics, Andersen's Behavioural Model of Health Services Use, Birth cohort

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. 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. 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 important, as it can maintain maternal and child’s health [3] and can contribute to a cost-effective health care system.

In Germany the Federal Joint Committee (G-BA) defines which examinations and services are offered and the costs of which are covered by the statutory health insurance funds to all insured persons during pregnancy according to the current state of medical knowledge, considering expediency and cost-effectiveness. This includes counselling of pregnant women, examinations to detect at-risk-pregnancies, three fetal sonographies or serological examinations. Regularly visits should take place at four-week intervals, with two examinations in each of the last two months of pregnancy. If risk status arises further examinations such as additional fetal sonographies may be indicated [4]. This study focusses on the use of prenatal screening and diagnostics outside of regular care which was specified as the use of at least one medically indicated or non-medically necessary prenatal diagnostic examination: advanced 2nd trimester anatomy ultrasound, amniocenteses, first trimester screening, 3D or 4D ultrasound, cordocentesis, translucency measurement, chorionic villus sampling or non-invasive prenatal testing of maternal blood and considered dichotomized.

Prenatal genetic screening has gained importance in recent years [5]. 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 genetic screening [6]. A more detailed consideration reveals a decrease of invasive prenatal genetic screening in favour of an increase in non-invasive prenatal genetic screening in recent years [5]. 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 genetic screening use [5, 7].

An established model to describe health services use is the Behavioural Model of Health Services Use developed by R.M. Andersen [8], which has been revised several times [9, 10]. The advantage of the model is, that it considers a wide range of determinants of health system use [11, 12]. 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) [10]. For better understanding the model is illustrated in Fig. 1.

Even though this framework is frequently applied to investigate health system use [8], only a few studies have so far considered the period of pregnancy [13–17]. 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 screening and

![Fig. 1 Behavioural model of health service use including contextual and individual characteristics, modified according to Andersen [10]](image)
diagnostics in Germany as well as to identify influencing factors. Analyses are based on Andersen’s Behavioural Model of Health System Use [10].

**Materials and methods**

We obtained data from a prospective birth cohort study, the KUNO Kids Health Study, initiated in June 2015 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 3000 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 164000 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].

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 by study team members 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. A more detailed description of the variables assessed is provided in supplementary information section (Additional file 1).

**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 min, 15 to 30 min, 30 to 60 min, more than 60 min), 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

| Table 1: Predictor variables |
|-----------------------------|
| **Predisposing Factors**    | **Enabling Factors** | **Need Factors** |
| Maternal age                | Health insurance    | At-risk-pregnancy |
| Primiparous/multiparous     | Travel time to obstetrician | Complications |
| Single parenting            | Health literacy     | during pregnancy  |
| Country of birth other than Germany | Social support | Pre-existing illness |
| German language skills      |                     |                  |
| Education level             |                     |                  |
| No employment before maternity leave |             |                  |
| Smoking behaviour           |                     |                  |
| Physical activity in the year before pregnancy |         |                  |
| Unhealthy diet              |                     |                  |
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. The sum of the items leads to a score between 0 and 50 points, whereas a higher score level is associated with higher health literacy. Additionally, 4 groups may be performed inadequate (0–25), problematic (25–33), sufficient (33–42) and excellent health literacy (42–50). For the statistical calculations carried out in this paper, health literacy was analysed as a continuous variable [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 an at-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 an at-risk-pregnancy or not) were answered by the mother in the interview. The variable at-risk-pregnancy refers to the definition of the maternity guideline catalogue, respectively the entry in the maternal routine care document (so called “Mutterpass”). It was assessed by self-report in the standardized interview and not medically verified, but as the interview was conducted by trained study team members the mother was well informed about the criteria.

Outcome
This study focusses on supplementary prenatal screening and diagnostics which 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: advanced 2nd trimester anatomy ultrasound, amniocenteses, first trimester screening, 3D or 4D ultrasound, cordocentesis, translucency measurement, chorionic villus sampling or non-invasive prenatal testing of maternal blood and considered dichotomized. If any of these examinations was performed the outcome “supplementary prenatal diagnostics” was considered “yes”, if none of them was used the outcome was considered “no”. This means that the examinations covered in the analyses go beyond recommendations for routine prenatal diagnostics in case of a non-at-risk pregnancy and are independent of the medical indication. However, they are recommended and therefore covered by the statutory health insurance if medically necessary for example a 3/4D ultrasound if a heart failure is suspected [4].

Statistical analyses
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
Two thousand six hundred fifty seven infants and their families have joined the study between its start on 27th June 2015 and 28th June 2018. The study sample is defined as all mothers who participated in the interview and answered the baseline questionnaire. After excluding cases with missing values on the analytical variables, 1886 cases were left for analyses (Fig. 2).

A non-responder analysis was also conducted for a selected observation period. This showed that one third of all potential families could be included in the study. Reasons for non-participation were, for example, a stay at the intensive care unit or an outpatient birth. The entire detailed non-responder analysis can be found elsewhere [23].

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. Mean level of health literacy was 35.6%. A large part of the population studied shows sufficient levels of health literacy (42.7%), however 38.8% had an inadequate or problematic literacy and only 18.5% an excellent health literacy. As the clinic St. Hedwig is level one perinatal centre the number of at-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 2.
Univariable analyses
In univariable analyses (Table 3), the predisposing factor maternal age indicated a higher chance of supplementary prenatal screening and 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 screening and diagnostics use.

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

Multivariable analyses
The chance of using supplementary prenatal screening and diagnostics (Table 4) 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 screening and diagnostics more than doubled if the mothers had a private health insurance. Similarly, a reported at-risk-pregnancy significantly increased the chance of supplementary prenatal screening and diagnostics use with respect to need characteristics. Having a pre-existing illness did not remain significant in the multivariable model (Table 4).

Discussion
The present study assessed the amount and determinants of supplementary prenatal screening and 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 screening and diagnostics more than doubled if the mother had a private health insurance. However, regarding need factors only having an at-risk-pregnancy was independently associated with supplementary prenatal screening and diagnostics use.

To the best of our knowledge, this is the first study using Andersen's model to describe supplementary prenatal screening and diagnostics use in Germany. Earlier studies mainly focused on timing and content of antenatal care [2, 14–18]. Further, most studies regarding prenatal diagnostics were set outside of Germany [30, 31] or did not apply Andersen's model [5]. 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 screening and diagnostics use in Germany.

Predisposing factors
Higher maternal age is associated with at-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 [32]. Our findings identifying maternal age as predictor for the use of supplementary prenatal screening and diagnostics are in line with a recent study describing maternal age as the strongest predictor for undergoing invasive genetic testing, respectively the use of prenatal diagnostics in general [30].

Our results indicate a higher chance of using supplementary prenatal screening and 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 [33, 34]. Even though the data of these studies did not permit an analysis of the causes, higher morbidity rates due to smoking [33] as well as a less health conscious behaviour [34] were discussed. However, our results are in contrast to previous studies reporting smoking as risk factor for an inadequate use
of antenatal care [14, 15] 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

### Table 2: 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                               | Mean   | SD    | Min / Max |
|------------------------------------------------|--------|-------|-----------|
| 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   |           |

| Health literacy (European Health Literacy Survey (HLS-EU-Q47))a | Mean   | SD    | Min / Max |
|                                                               | 35.62  | 7.317 | 0 / 50    |

| Social support (short version of the social support questionnaire (F-SozU K-14))b | Mean   | SD    | Min / Max |
|                                                                               | 4.43   | 0.525 | 1.2/ 5.0  |

| Need factors                                                                 | N      | %     |
|-----------------------------------------------------------------------------|--------|-------|
| At-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      | %     |
|----------------------------------------------------------------------------|--------|-------|
| Supplementary prenatal diagnostics use                                       | 1453   | 79.9  |

SD: Standard deviation

*a* Interview

*b* Baseline questionnaire
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.

### Table 3 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 <10 years) | | | |
| 10 years | 1.167 | 0.748 | [0.455; 1.991] |
| >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** | | | |
| At-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; 1.245] |
| Pre-existing illness | 1.313 | 0.025* | [1.036; 1.665] |

Odds Ratio, 95% CI; 95% confidence interval, *P-Value < 0.05, **P-Value < 0.01

### Table 4 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** | | | |
| At-risk-pregnancy | 1.688 | <0.001** | [1.271; 2.241] |

Odds Ratio, 95% CI; 95% confidence interval, *P-Value < 0.05, **P-Value < 0.01

Enabling factors

To better understand the results concerning health insurance, it is important to know, that in Germany, both privately and statutorily insured persons are usually treated in the same clinics. However, the medical fee differs depending on the insurance [35]. Some private health insurances also cover services that go beyond those covered by the statutory health insurance [36].

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, 37]. 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 [38–41]. 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 [42]. 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 [10, 43].

The above-mentioned findings are according to our analyses concerning educational attainment, which
revealed a higher chance for the use of supplementary prenatal screening and diagnostics with a higher educa-
tional attainment. However, the association was not significant. This is in line with findings from the Rob-
ert Koch Institute which did not support an association between education and health care use, but strong differ-
ences according to social conditions [44].

Need factors
Most studies addressing health system utilisation reported need factors as strong factors involved [11, 13]. However,
regarding supplementary prenatal screening and diagnostics only the variable “having an at-risk-pregnancy” showed
an independent association, whereas no significant association between the other need factors and the use of supple-
mentary prenatal screening and diagnostics was found. The positive association between an at-risk-pregnancy and sup-
plementary prenatal screening and 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. [14]. The relatively small association with need factors in general
and the important role of the type of health insurance was surprising and worrisome as it indicates social disparities
in supplementary prenatal screening and diagnostics use, however it contributes to the above mentioned hypothesis
by Andersen et al. [43, 45].

Frequency of utilisation of supplementary prenatal diagnostics
Regarding the frequency of use of supplementary prenatal screening and diagnostics comparisons are limited as
official statistics are lacking and most studies analysed utilisation rates for special examinations such as translu-
cency measurement and not the total amount of supplementary prenatal screening and diagnostics use [5]. 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 level one 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 at-risk pregnancies [23] which could lead
to higher health care utilisation rates during pregnancy. On the other hand, the prevalence of at-risk-pregnancies
in the study sample is 42%, which does not differ considerably from the Bavarian average of 36% [46]. A fur-
ther limitation is that at-risk-pregnancy was assessed by self-report and not verified by a medical diagnosis.
However, it was assessed in the standardised interview by trained study team members after precisely informing
the mother about the criteria referring to the maternity guideline catalogue.

The use of self-report data on the utilisation of supplementary prenatal screening and diagnostics is a limita-
tion of our study. Bias due to memory effects cannot be fully excluded. Despite, as these examinations require
information and consent of the mother before being conducted it can be supposed that they are well remembered.

Due to language barriers migrants are often under-represented in population based research [23, 47]. 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 [37].

There is an underrepresentation of the lowest education group [48]. This may be an explanation why educa-
tional level did not show a significant association to supplementary prenatal screening and diagnostics use.
Nevertheless, also findings from the Robert Koch Institute did not support an association between education
and supplementary prenatal screening and diagnostics use [44]. Furthermore due to overrepresentation of well-educated
women the study population may show higher health literacy levels as previous findings for a representative sample of the German population
[27]. However, in general, it can be said that women who would otherwise have been unattainable, could
be included to the study due to the special efforts in recruitment such as presenting the study to each
mother by study team members.

Conclusion
The study provides comprehensive data from a large sample of mothers on the utilisation of health care dur-
ing 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 consid-
ered when discussing equity in accessing health care. The present study focusses on the use of prenatal diag-
nostics outside of regular care without reference to the medical indication. However, the insights gained may
be used as basis to establish further research to identify
ways to use health system in a needs-based manner by presenting intervention options, such as reducing differences between statutory and private health insurance in order to prevent missing a diagnosis due to not using an important examination, or on the other hand not causing unnecessary concern due to the use of irrelevant examinations. Therefore, it is important to provide the information mothers need to discriminate about the adequacy of screening.

**Abbreviations**
HELPP: Hypertension, Elevated Liver enzymes and Low Platelets; HL: Health literacy; KUNO: Kinder Uniklinik Ostbayern (children’s university hospital for the region of Eastern Bavaria).

**Supplementary Information**
The online version contains supplementary material available at https://doi.org/10.1186/s12884-022-04692-1.

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**KUNO Kids Study group.**
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1 University Children’s Hospital Regensburg (KUNO), Hospital St. Hedwig of the Order of St. John, Germany.
2 University Department of Obstetrics and Gynecology, Hospital St. Hedwig of the Order of St. John, University Medical Center Regensburg, DE, Germany.
3 Institute for Social Medicine and Health Systems Research (ISMG), Leipzigerstr. 44, 39120 Magdeburg, Germany.
4 Department of Pediatrics and Adolescent Medicine, Johannes Kepler University Linz, Linz, Austria.
5 Department of Pediatric Pneumology and Allergy, University Children’s Hospital Regensburg, St. Hedwig Campus, Regensburg, Germany.
6 Department of Sydney, Children’s Hospital Regensburg, Regensburg, Germany.
7 Bavarian Health and Food Safety Authority (LGL), Munich, Germany.
8 Department of Pediatric Urology, University Medical Center, Regensburg, Germany.
9 Pediatric Allergology, Dept of Pediatrics, Dr. von Hauner Children’s Hospital, University Hospital, LMU Munich, Munich, Germany.
10 Institute of Human Genetics, University of Regensburg, Regensburg, Germany.
11 Department of Dermatology, Venereology and Allergy, University Hospital Schleswig-Holstein, Campus Kiel, Kiel, Germany.

**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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**Availability of data and materials**
The datasets used and analysed for this paper are available from the corresponding author on reasonable request.

**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. All methods carried out were in accordance with relevant guidelines and regulations (Declaration of Helsinki).

**Consent for publication**
Not applicable.

**Competing interests**
The authors declare that they have no competing interests.

**Author details**
1 University Children’s Hospital Regensburg (KUNO), Hospital St. Hedwig of the Order of St. John, Steinmetzstr. 1-3, 93049 Regensburg, Germany.
2 Medical Sociology, Institute of Epidemiology and Preventive Medicine, University of Regensburg, Regensburg, Germany.
3 Institute for Social Medicine and Health Systems Research (ISMG), Leipzigstr. 44, 39120 Magdeburg, Germany.
4 Research and Development Campus (WECARE), Hospital St. Hedwig of the Order of St. John, Regensburg, Germany.
5 Bavarian Health and Food Safety Authority, Bad Kissingen, Germany.
6 University Children’s Hospital Regensburg, Hospital St. Hedwig of the Order of St. John, University Medical Center Regensburg, Regensburg, Germany.

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