Original Research

Development of Mothers' Health Literacy: Findings From the KUNO-Kids Study

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ABSTRACT

Background and **Objective:** The aim of this study was to analyze the longitudinal development of health literacy (HL) in a large cohort of new mothers in Germany and to investigate which determinants are associated with the initial HL level and with change over time. **Methods:** Longitudinal data from 1,363 mothers participating with their child in the KUNO-Kids Health Study was used; data were collected at birth of the child (baseline), after 6 and 12 months, using interviews and self-report questionnaires. The HL of mothers was assessed with the health care scale of the European Health Literacy Survey Questionnaire, which has 16 items on accessing, understanding, appraising, and applying health information in the health care setting. Latent growth curve models were used to analyze average trajectories and predictors of HL in the total sample and in the subgroup of first-time mothers. **Key Results:** HL values increased from baseline (M = 35.46, standard deviation [SD] = 7.34) over 6 months (M = 37.31, SD = 7.31) to 12 months (M = 38.01, SD = 7.41). The increase was statistically significant in the total sample (1.188, standard error [SE] = 0.087, $p < .001$) and in the subgroup of first-time mothers (1.357, SE = 0.113, $p <. 001$), with a steeper trajectory for mothers with lower HL at baseline. Several personal and situational variables were associated with HL at baseline (e.g., education, child health) and with its development (e.g., number of children). **Conclusion:** Overall, new mothers became slightly more health literate during their child's first year of life. However, some groups of mothers could benefit from support in developing HL skills even before childbirth. [***HLRP: Health Literacy Research and Practice*. 2023;7(1):e39–e51.**]

Plain Language Summary: We investigated how health literacy (that is the ability to find, understand, and apply health information) develops in new mothers in Germany. Mothers told us that this ability slightly improved during the child's first year of life. Some mothers still have difficulties in dealing with health information; these mothers should be supported even before childbirth.

Health literacy (HL) describes the knowledge, motivation, and competencies of accessing, understanding, appraising, and applying health-related information in health care, disease prevention, and health promotion, respectively (Sørensen et al., 2012). Most existing conceptual models of HL do not put a special focus on the development of HL over time; however, a few models adopt a life course perspective (Maindal & Aagaard-Hansen, 2020; Sørensen et al., 2012). They consider HL skills and competences to be continuously challenged over the life course, especially after changes in health status or life events. HL is assumed to mature and to accumulate since different phases during life-course require different domains of HL which in turn are also influenced by various social determinants (Maindal & Aagaard-Hansen, 2020).

A particularly interesting subgroup in this lifelong development process are parents. They are considered not only responsible for their own health but also for the health of their children (de Buhr & Tannen, 2020). Several studies investigated the effect of parental HL on health behaviors directed at the child (Pawellek et al., 2022) and child health outcomes revealing associations of high parental HL with favorable health behaviors (Albino et al., 2018; de Buhr & Tannen, 2020; Heerman et al., 2014; Yin et al., 2014). With the birth of a child several new information needs emerge (Cashin et al., 2021). Caring for the child, communicating with other parents and contacts to the health care system can be situations when parents are exposed to health information and in which HL is supposed to be crucial (Morrison et al., 2019). The challenges of child (health) care might be even greater for first-time parents: First-time mothers experience more problems with breastfeeding (Buckman et al., 2020; Hackman et al., 2015), use more often child health care services (Lagerberg & Magnusson, 2013) and are less informed about psychosocial support services (Brandstetter, Rothfuß et al., 2020).

When it comes to the development of HL over time the lack of empirical studies is striking. Previous studies with parents focused on mostly sociodemographic predictors

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(Brandstetter, Atzendorf et al., 2020; de Buhr & Tannen, 2020; Kampouroglou et al., 2021) and health outcomes of HL (DeWalt & Hink, 2009; Firmino et al., 2018) or tested interventions which foster HL (Khan et al., 2018; Morrison et al., 2013; Peyton et al., 2019). Therefore, it is important to discover the underlying processes of HL development in parents and what factors can positively influence these changes.

OBJECTIVES

The objective was to analyze the trajectory of development of HL and its determinants in a large cohort of new mothers (both first-time mothers and mothers already having a child) in Germany.

The following research questions were pursued:

1. How is the trajectory of the mean development of HL over a period of 1 year (descriptive analysis)?
2. Which determinants explain differences between individual growth curves (predictive analysis)?

MATERIALS AND METHODS

Design

This study had an observational longitudinal design and used data from mothers participating in the KUNO-Kids Health Study, a prospective multipurpose birth cohort study (Brandstetter et al., 2019) conducted in the St Hedwig Clinic (Regensburg, East Bavaria, Germany). Recruitment of the study started in June 2015 and is still ongoing. The study has been approved by the Ethics Committee of the University of Regensburg (reference number: 14-101-0347).

Participants and Data Collection

Women were approached in the last trimester of pregnancy or during their hospital stay after delivery and were invited to participate in the study. Mothers were eligible for enrollment if they were at least age 18 years and if they were able to provide informed consent. Only one child per family was included in the study. Data were collected at three measurement points: at birth of the child (baseline), after 6 months, and after 1 year. Data were collected using standardized computer-assisted personal interviews and paper-based self-report questionnaires. For the analysis sample, all mothers who participated in the study for at least 1 year were included (recruited until March 2019 with the last assessment in March 2020). The dataset was further restricted to participants that completed at least two HL assessments. Subgroup analyses were performed for first-time mothers.

MEASURES

Outcomes

Mothers' HL was assessed with the German version of the health care scale of the standardized European Health Literacy Survey Questionnaire-47 (HLS-EU-Q47) (Sørensen et al., 2013), which was developed based on the conceptual model of HL of Sørensen et al. (2012) (internal consistency: Cronbach's alpha = .91 [Schaeffer et al., 2016]; Pearson correlation with the general HL-index: r = .90 [HLS-EU Consortium]). The scale comprises 16 items, scored on a 4-point Likert scale (*very difficult*, *quite difficult*, *quite easy*, *very easy*). Four items each are covering the domain accessing, understanding, appraising, and applying health information in the health care setting, respectively. A mean score was calculated and transformed to a metric from 0 to 50 with higher scores indicating higher HL. For descriptive purposes the scores were categorized into four levels of HL: *inadequate* (0-25), *problematic* (26-33), *sufficient* (34-42), and *excellent* (43-50) (Schaeffer et al., 2017).

Predictor Variables

Variables considered as predictors of mothers' HL and its development over time were selected following the conceptual model of HL (Sørensen et al., 2012). Personal determinants comprised socio-demographic and health-related variables, situational determinants comprised variables indicative of social and professional support and interactions with the health care system. The variable selection was further informed by recent studies investigating determinants of HL, using the HLS-EU questionnaire (Brandstetter, Atzendorf et al., 2020; Garcia-Codina et al., 2019; Schaeffer et al., 2017; Svendsen et al., 2020). Predictor variables were assessed directly after delivery or after 4 weeks. For detailed information about predictor variables see **Table A**.

Statistical Analysis

Descriptive data are presented as mean (standard deviation [*SD*]) when normally distributed or as median (interquartile range) in case of skewed data. Categorical data are presented in frequencies (%). Selection bias was determined by comparing general characteristics (e.g., age, education) and HL at baseline between participants who were included and not included, respectively (see participants and data collection).

Latent growth curve models within the structural equation framework were used to analyze sample average trajectories as well as individual differences in growth and predictors of HL in new mothers, each for the total analysis sample and the subgroup of first-time mothers. Normal distribution of

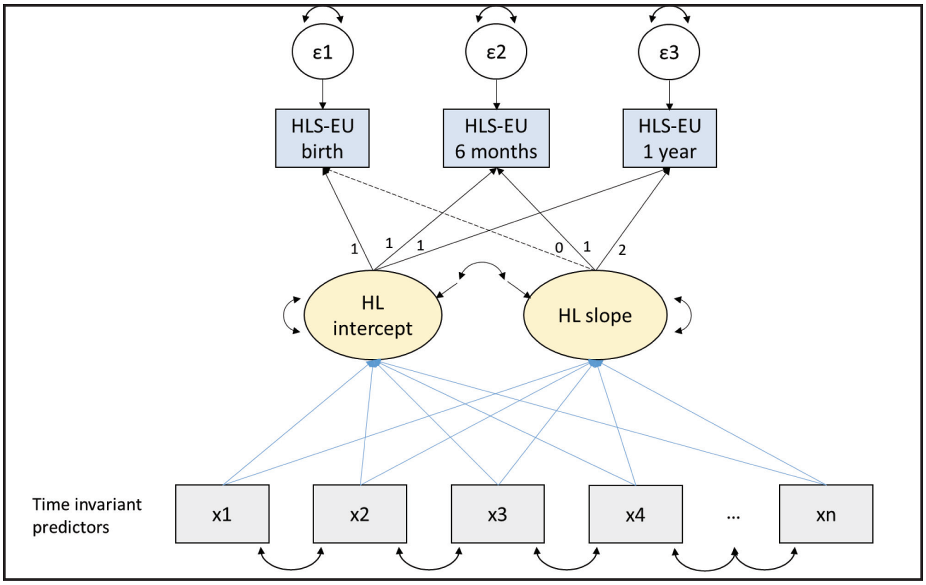

Figure 1. Growth curve model. Schematic diagram of the latent growth curve model with time invariant predictors. Measurements of the European Health Literacy Survey Questionnaire (HLS-EU) at birth, 6 months and 1 year represent indicator variables of the latent health literacy (HL) construct. For reasons of simplicity, only an exemplary number of time invariant predictors (x1 – xn) is outlined here.

indicator variables (HL) was approved, and predictor variables were checked for collinearity by inspecting bivariate correlations and by examining VIF (variance inflation factor) and tolerance. For all predictor variables included in the multivariable model, neither VIF nor tolerance indicated multicollinearity: VIF values ranged between 1.06 and 2.07 and tolerance values between .48 and .94, respectively. To account for missing values within the HLS-EU items, multivariate imputation by chained equations (MICE) was performed using the MICE package in R (Buuren & Groothuis-Oudshoorn, 2011). Results of 10 multiple imputations were combined by computing the mean or selecting the most likely imputed value and analyses were performed on this merged data set. Maximum likelihood estimation methods were applied including full information maximum likelihood (FIML) for handling missing values within predictor variables. The total amount of missingness throughout the dataset was 5.1%, whereby resulting estimators and standard deviations were assumed unbiased (Cheung, 2007). We additionally checked for patterns and randomness of missing data.

For both growth models (total analysis sample; subgroup of first-time mothers) the best fitting unconditional model (without predictors) was built using stepwise backward model selection (Kim et al., 2018) relying on the following criteria for model evaluation: ΔAIC (Akaike information criterion), ΔBIC (Bayesian information criterion), ΔCFI (comparative fit index), ΔRMSEA (root mean squared error of approximation), ΔSRMR (standardized root mean square residual). Afterwards, this best fitting growth trajectory was extended by including all a priori defined predictors as time-invariant covariates, resulting in the conditional growth model **(Figure 1)**. As no longitudinal studies of HL exist, it is still unknown what form and size the trajectory could take. When specifying the analysis plan prior to data analysis (Pawellek & Brandstetter, 2021), a linear increase was assumed considering the continuously developing HL demands and exposure to health information during early parenthood. Factor loadings of the slope factor were set to 0, 1, and 2 corresponding to the metric of the assessments (0 months, 6 months, 12 months).

Regression coefficients with 95% confidence intervals (CI) show the association of the predictors with the initial level and trajectory of HL. Different fit indices (chi-square goodness of fit test, CFI, Tucker-Lewis index [TLI], RMSEA, and SRMR) indicate how good the model fits to the data. Model fit was considered good (adequate) if RMSEA <.05 (<.08), SRMR <.05 (<.08), CFI >.95 (>.90), and TLI >.95 (>.90) (Hu & Bentler, 1999; Kline, 2016; Tucker & Lewis, 1973). No a priori sample size calculation was performed as no longitudinal studies with the HLS-EU questionnaire (Sørensen et al., 2013) exist providing measures of effect size. However, with a sample size of n = 1,363 model requirements were fulfilled (Curran et al., 2010). To inform future studies, post-hoc reliability measures of slope variance (e.g., effective curve reliability [Brandmaier et al., 2018]) were calculated that can be interpreted as standardized effect size measures of the total latent information about individual differences in linear slope.

Statistical analyses were performed according to an a priori specified analysis plan (Pawellek & Brandstetter, 2021). The reporting follows the guidelines for reporting observational studies [STROBE statement, von Elm et al. (2007)]; see STROBE checklist **Table B**). Data were cleaned using SPSS version 26 (IBM Corp. Released 2019. IBM SPSS Statistics for Windows, Version 26.0. Armonk, NY: IBM Corp). All analyses were conducted using R version 4.0.2 (2020-06-22; The R Foundation for Statistical Computing; Vienna, Austria) and the lavaan package (Rosseel, 2012).

RESULTS

Descriptive Analyses

The total sample of mothers recruited for the KUNO-Kids Health Study until March 2019 comprised *N* = 2,685. Mothers (*n* = 1,316) were excluded due to dropouts before 1-year assessment, six due to less than two HL assessments. Finally, 1,363 mothers were included for analyses **(Figure 2)**. The characteristics of the total sample and the analysis sample are displayed in **Table C**.

In **Table 1**, the baseline characteristics for included participants are presented. Mean HL score was at baseline 35.46 (*SD* = 7.34), after 6 months 37.31 (*SD* = 7.31) and after 1 year 38.01 (*SD* = 7.41) (Cronbach's alpha at baseline: .90). At baseline, more than one-third (38.7%) showed limited HL, whereby this proportion decreased to 27.2% after 6 months and 23.9% after 1 year.

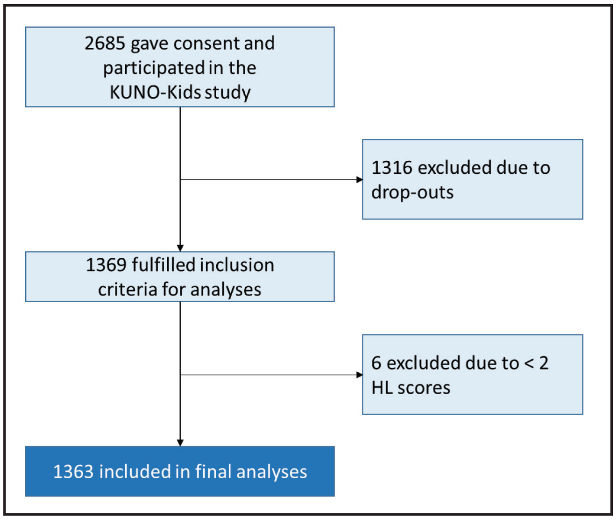

Figure 2. Flow diagram of participants included in the analyses. HL = health literacy.

Latent Growth Curve Modelling

Unconditional model. First, an unconditional linear model, specifying the repeated measures as a function of an intercept and linear slope (coding in the metric of time: 0 months, 6 months, 12 months), was estimated. Backward model selection revealed that the unconstrained linear model fit the data best. Parameter estimates indicated a significant increase in mothers' HL (1.188, *SE* = 0.087) over 1 year as well as significant variability in the intercept (39, *SE* = 2.254) and slope (5.950, *SE* = 0.894). Further, the model revealed a significant negative covariance (–2.850, *SE* = 0.976), suggesting that mothers with a lower initial HL level showed a steeper increase in HL over 1 year. Effective curve reliability was .70. All estimates with the related 95% CIs and *p* values are presented in **Table D**.

Conditional model. Given that model estimates indicated significant variance in mothers' HL around the mean for both intercept and slope, baseline predictors were specified in a conditional model. Results from the ML estimation of the linear model with the predictor variables yielded χ^2 (34) = 50.683 (p = .033) and indicated good model fit for all indices: CFI = .993, TLI = .979, RMSEA = .019 (90% CI: [.006, .029]), SRMR = .004.

Table 2 displays the results of the conditional model. High educational level and high subjective social status were significant predictors of the intercept, indicating that women with more than 10 years of schooling (compared to a medium educational level) as well as women with higher social status had a higher HL score at baseline. Being overweight compared to having normal weight and low child birthweight compared to normal birthweight were associated with lower HL. Former smoker compared to non-smoker had a 1 point higher HL score at baseline. Also, subjective child health status was positively related with HL at baseline. Concerning psychosocial constructs higher parenting stress regarding parent-child bond was associated with lower HL scores. More social support was associated with higher HL. Regarding the slope factor mothers with more than one child had a less steep increase in HL over 1 year than first-time mothers, a better physical health (measured by Short Form-12 physical component scale) and visits to more than three different doctors during pregnancy were associated with a steeper increase in HL.

Subgroup Analyses of First-Time Mothers

The subgroup of first time-mothers comprised 830 women. Mean HL score was at baseline 34.99 (*SD* = 7.45), after 6 months 37.08 (*SD* = 7.37) and after 1 year 37.91 (*SD* = 7.38). The subgroup analysis also revealed a significant increase in HL over 1 year, significant variability in the intercept and slope, and significant negative covariance (**Table E**). Results from the ML estimation of the linear model with the predictor variables yielded χ^2 (33) = 43.731 (p = .100) and indicated good model fit for all indices: CFI = 0.992, TLI = 0.977, RMSEA = 0.020 (90% CI: [0.000, 0.034], SRMR = 0.005. The pattern of findings (see **Table 3**) was comparable to the whole sample of mothers: high education, higher social status and parenting stress regarding parent-child bond were associated with higher HL at baseline. Maternal overweight and low child birthweight revealed significantly lower HL compared to normal weight of mother and child, respectively. High child birthweight compared to normal birthweight was associated with higher HL. Overweight as well as obese women

TABLE 1

Baseline Characteristics of Participants (*N* = 1,363)

Characteristic	*N*	*n* (%)	Mean (*SD*)/ Median (IQR)
Personal determinants			
Age (years)	1,351		32.62 (4.15)
Marital status	1,339		
Married, living together with husband		1,101 (82.2)	
Unmarried, living together with partner		215 (16.1)	
Living without partner/divorced/widowed		23 (1.7)	
Migration background (country of birth Germany)	1,341	1,209 (90.2)	
Maternal education	1,336		
No degree or less than 10 years of schooling		91 (6.8)	
Ten years of schooling		407 (30.5)	
University entrance level		838 (62.7)	
Maternal employment before pregnancy	1,337	1211 (90.6)	
Primiparous	1,352	830 (61.4)	
Subjective social status	1,213		6.72 (1.24)
No risk pregnancy	1,331	763 (57.3)	
No history of chronic or severe disease	1,183	455 (38.5)	
Weight status before pregnancy	1,335		
Underweight (BMI <18.5)		54 (4)	
Normal weight (BMI 18.5-24.9)		909 (68.1)	
Overweight (BMI 25-29.9)		234 (17.5)	
Obese (BMI >30)		138 (10.3)	
Preterm birth	1,350	168 (12.4)	
Child birthweight	1,352		
Low birthweight (<2,500 g)		70 (5.2)	
Normal birthweight (2,500-4,500 g)		1266 (93.6)	
High birthweight (>4,500 g)		16 (1.2)	
Child health status	1,211		95 (90-100)
SF-12 Mental Component Summary scale	1,170		47.58 (10.44)
SF-12 Physical Component Summary scale	1,170		47.06 (8.38)
EBI parental competence scale	1,227		7.69 (3.67)
EBI parental bond scale	1,222		8.48 (3.34)
Smoking	1,229		
Current smoker		18 (1.5)	
Former smoker		550 (44.8)	
Non-smoker		661 (53.8)	
No alcohol consumption during pregnancy	1,227	1,208 (98.5)	
Fruits/vegetables consumption during pregnancy (almost daily)	1,336	693 (51.9)	
Situational determinants			
Social support (F-SozU K-14 [Social Support Questionnaire])	1,182		4.30 (0.46)
No social or emotional burden	1,194	864 (72.4)	

showed a steeper HL increase over 1 year compared to mothers with normal weight before pregnancy.

DISCUSSION

We showed that HL slightly increased over a period of 1 year with a steeper trajectory for mothers who start with a lower HL level at baseline. Educational level, subjective social status, child health, social support, parenting stress regarding parent-child bond, former smoking, weight status before pregnancy, and child birthweight were associated with HL at baseline. The development of HL over 1 year was associated with the number of children, physical component scale of health-related quality of life and the number of different doctors visited during pregnancy.

In the subgroup of first-time mothers, our model revealed quite similar results suggesting education, social status, parenting stress regarding parent-child bond, maternal weight status, and child birthweight as predictors of the level of maternal HL at birth of the child. Maternal weight status was further associated with the change of HL over 1 year.

Our study expands previous research by considering a more comprehensive set of predictors of HL and by employing a longitudinal study design. Referring to the conceptual model of HL (Sørensen et al., 2012) variables covering personal and situational determinants were selected. Our results support the previously reported positive associations between high education and higher social status, and HL (de Buhr & Tannen, 2020; Schaeffer et al., 2021), but revealed additional personal and situational factors that act as facilitators in the process of the development of HL.

More importantly, our study investigated influencing factors on the development of HL over time. With the transition to parenthood health-related topics gain more importance (Cashin et al., 2021), whereby mothers giving birth to their first child are hypothesized to experience greater changes. This is reflected in our study by a steeper increase in HL over 1 year compared to mothers with more than one child. Furthermore, visiting a high number of health professionals during pregnancy was also related with a steeper trajectory of HL. Edwards et al. (2012) showed that health professionals were supportive in the development of HL by encouraging patients to engage with information before making a treatment choice. Finally, our study revealed that better physical health-related quality of life as well as overweight before pregnancy were associated with a steeper increase of HL over 1 year. These quite contrasting results could be explained by differences in perceived barriers, challenges, and other motivational reasons not captured in our study (Ha et al., 2020).

Overall, the mean increase of mothers' HL over the first year after childbirth was slight and only few investigated factors predicted changes in HL. Adopting the life-course perspective each critical phase of life is predominated by different domains of HL (e.g., physical literacy, food literacy, reproductive literacy) and influenced by other personal and situational factors (Maindal & Aagaard-Hansen, 2020). The transition to parenthood is assumed to represent such a phase of life in which new demands emerge and in which parental HL may become more important. Until now, there are no studies that tried to determine clinically significant changes (minimal important differences) in HL and the HLS-EU and other HL measurement instruments have originally not been designed to pick up change over time. Therefore, available validation data do not encompass sensitivity of change or interpretability of change scores. This makes the evaluation of the HL increases in terms of clinical significance difficult. However, our results suggest that early parenthood per se and the associated contacts with the health care system or other health information have only little influence on the "naturally" occurring development of mothers' HL. It could also be that the continuing exposure to health information takes more time than 1 year to eventually translate in increases in HL. Thus, targeted efforts seem to be necessary to strengthen the HL of new mothers.

Although little is known about how to strengthen HL in the group of pregnant women or new parents, (Melwani et

TABLE 1 (CONTINUED)

Baseline Characteristics of Participants (*N* = 1,363)

Characteristic	*N*	*n* (%)	Mean (*SD*)/ Median (IQR)
Number of different doctors visited during pregnancy (in addition to obstetrician/ gynecologist)	1,196		
1st tertile (0-1 doctors)		433 (36.2)	
2nd tertile (2 doctors)		410 (34.3)	
3rd tertile (3-11 doctors)		353 (29.5)	
Utilization of midwife services	1,250	1,204 (96.3)	
Utilization of psychosocial support services	1,316	1,118 (85)	
Statutory insurance	1,332	1,111 (83.4)	
Health literacy[a]			
Baseline	1,363		35.46 (7.34)
Inadequate		101 (7.4)	
Problematic		426 (31.3)	
Sufficient		572 (42)	
Excellent		264 (19.4)	
6 months	1,363		37.31 (7.31)
Inadequate		60 (4.4)	
Problematic		311 (22.8)	
Sufficient		616 (45.2)	
Excellent		376 (27.6)	
1 year	1,363		38.01 (7.41)
Inadequate		50 (3.7)	
Problematic		276 (20.2)	
Sufficient		599 (43.9)	
Excellent		438 (32.1)	

Note. BMI = body mass index; EBI = Eltern-Belastungs-Inventar [parenting stress index]; IQR = interquartile range; *SD* = standard deviation; SF-12 = Short Form-12.
[a]Number of participants with health literacy score before imputation: baseline, *N* = 1,284; 6 months, *N* = 1,172; 1 year, *N* = 1,305.

TABLE 2

Results of the Conditional Latent Growth Curve Model of Health Literacy (N = 1,363)[a]

Predictors	Initial Status (Intercept)			Growth (Slope)		
	Coefficient (Standardized)	SE	CI 95%	Coefficient (Standardized)	SE	CI 95%
Personal determinants						
Age	–0.053 (–0.035)	0.055	[–0.161, 0.055]	0.012 (0.020)	0.026	[–0.038, 0.062]
Married, living together with husband (ref)						
Unmarried, living together with partner	–0.214 (–0.013)	0.524	[–1.242, 0.813]	0.153 (0.023)	0.243	[–0.324, 0.629]
Living without partner	0.126 (0.003)	1.475	[–2.765, 3.016]	0.667 (0.035)	0.683	[–0.672, 2.005]
Migration background	–0.710 (–0.034)	0.654	[–1.992, 0.572]	–0.172 (–0.021)	0.302	[–0.765, 0.420]
Low education	–0.158 (–0.006)	0.806	[–1.737, 1.420]	–0.326 (–0.033)	0.373	[–1.056, 0.405]
Medium education (ref)						
High education	2.128 (0.164)*	0.444	[1.258, 2.997]	–0.014 (–0.003)	0.206	[–0.417, 0.389]
Employment before pregnancy	0.169 (0.008)	0.660	[–1.124, 1.462]	0.125 (0.015)	0.305	[–0.473, 0.723]
Multiparous	0.772 (0.060)	0.429	[–0.069, 1.613]	–0.663 (–0.131)*	0.199	[–1.053, –0.273]
Subjective social status	0.602 (0.119)*	0.174	[0.261, 0.943]	–0.024 (–0.012)	0.081	[–0.183, 0.135]
Risk pregnancy	0.399 (0.031)	0.437	[–0.458, 1.256]	0.177 (0.036)	0.203	[–0.221, 0.575]
Chronic/severe disease	0.683 (0.053)	0.425	[–0.150, 1.516]	0.032 (0.006)	0.197	[–0.355, 0.418]
Underweight[b]	0.183 (0.006)	0.957	[–1.693, 2.060]	–0.547 (–0.044)	0.445	[–1.420, 0.326]
Normal weight[b] (ref)						
Overweight[b]	–0.999 (–0.061)*	0.498*	[–1.975, –0.022]*	0.442 (0.068)	0.232	[–0.013, 0.896]
Obese[b]	–0.430 (–0.021)	0.649	[–1.701, 0.842]	0.081 (0.010)	0.301	[–0.510, 0.671]
Preterm birth	0.773 (0.041)	0.620	[–0.442, 1.987]	–0.152 (–0.020)	0.288	[–0.716, 0.411]
Low birthweight	–2.940 (–0.104)*	0.923*	[–4.749, –1.131]*	0.115 (0.010)	0.427	[–0.722, 0.952]
Normal birthweight (ref)						
High birthweight	0.391 (0.007)	1.729	[–2.998, 3.780]	1.242 (0.055)	0.800	[–0.327, 2.810]
Child health status	0.047 (0.066)*	0.023*	[0.003, 0.092]*	–0.008 (-0.029)	0.011	[–0.029, 0.013]
SF-12 Mental Component Summary	0.029 (0.049)	0.024	[–0.018, 0.077]	–0.008 (–0.034)	0.011	[–0.030, 0.014]
SF-12 Physical Component Score	–0.004 (–0.006)	0.025	[–0.054, 0.046]	0.025 (0.085)*	0.012*	[0.002, 0.048]*
EBI parental competence	0.004 (0.002)	0.076	[–0.144, 0.152]	–0.035 (–0.052)	0.035	–0.103, 0.034]
EBI parental bond	–0.387 (–0.206)*	0.076*	[–0.536, –0.238]*	–0.047 (–0.063)	0.035	[–0.116, 0.023]
Current smoker	–0.380 (–0.007)	1.663	[–3.639, 2.879]	0.012 (0.001)	0.773	[–1.502, 1.527]
Former smoker	0.993 (0.079)*	0.401*	[0.207, 1.779]*	–0.299 (0.060)	0.186	[–0.664, 0.067]
Non-smoker (ref)						
Alcohol consumption during pregnancy	0.294 (0.006)	1.584	[–2.811, 3.398]	0.130 (0.007)	0.735	[–1.311, 1.571]
No daily fruits/vegetables consumption	–0.034 (–0.003)	0.380	[–0.779, 0.711]	0.191 (0.039)	0.178	[–0.158, 0.539]
Situational determinants						
Social support (FSozU)	1.097 (0.081)*	0.458*	[0.199, 1.996]*	0.210 (0.040)	0.212	[–0.205, 0.625]
Social/emotional burden	0.296 (0.021)	0.491	[–0.666, 1.258]	–0.156 (–0.028)	0.228	[–0.602, 0.291]

TABLE 2 (CONTINUED)

Results of the Conditional Latent Growth Curve Model of Health Literacy (N = 1,363)[a]

	Initial Status (Intercept)			Growth (Slope)		
Predictors	Coefficient (Standardized)	SE	CI 95%	Coefficient (Standardized)	SE	CI 95%
Low no. of different doctors (ref)						
Medium no. of different doctors	–0.813 (–0.062)	0.474	[–1.742, 0.116]	0.232 (0.045)	0.220	[–0.199, 0.663]
High no. of different doctors	–0.597 (–0.044)	0.513	[–1.602, 0.408]	0.510 (0.095)*	0.238*	[0.044, 0.975]*
No midwife service	1.649 (0.050)	1.054	[–0.417, 3.714]	0.598 (0.046)	0.480	[–0.343, 1.539]
No psychosocial support services	–0.489 (–0.028)	0.538	[–1.544, 0.566]	–0.005 (–0.001)	0.249	[–0.492, 0.483]
Private health insurance	–0.115 (–0.007)	0.527	[–1.148, 0.918]	–0.059 (–0.009)	0.244	[–0.53, 0.419]

Note. R^2 for intercept: .149, for slope: .057. CI = confidence interval; EBI = Eltern-Belastungs-Inventar [parenting stress index]; ref = reference; SE = standard error; SF-12 = Short Form-12.
[a]Total analysis sample.
[b]Weight status before pregnancy (body mass index: kg/m²).
*$p < .05$.

al., 2022; Nawabi et al., 2021) previous research indicates how HL can be increased in the general adult population. Systematic reviews of interventions to strengthen HL skills showed an overall benefit of clear health communication strategies, self-management support, empowerment, and supportive and caring environments (Hersh et al., 2015). Like many other countries, Germany has adopted a National Action Plan on Health Literacy (Schaeffer et al., 2018). It emphasizes that HL should be promoted in a societal approach in which the health care system has an important role. The period of starting a family could be considered a window of opportunity for promoting HL—by enabling the health care and the social services system to use the existing contacts with new parents in a manner that fosters HL.

STUDY STRENGTHS AND LIMITATIONS

To the best of our knowledge, this was the first study which investigated mothers' HL with a longitudinal design. All analyses including the selection of predictor variables were based on a conceptual model of HL (Sørensen et al., 2012) and were specified in the form of a statistical analysis plan.

HL was assessed using the validated standardized HLS-EU questionnaire, a subjective instrument capturing self-ratings about how easy or difficult people perceive their dealing with health information. For feasibility reasons only the health care subscale was applied in the study (high inter correlation between the subscales and the general HL-index [HLS-EU Consortium]). The disadvantage of subjective instruments is that responses might be biased due to social desirability or misjudgment of competences.

The KUNO-Kids Health Study comprises extensive assessments at various follow-ups. Data were collected with different administration modes (standardized computer-assisted personal interviews at baseline and paper-based self-report questionnaires for follow-up). Therefore, responses from interviews might be more likely to be biased regarding social desirability as compared to responses from self-report questionnaires. Considering this, HL assessment at the baseline interview might have led to higher HL values and an underestimation of mothers' HL increase over 1 year. Further, the effort imposed on participants by study procedures is considerable resulting in missing values and potential selection bias. We applied multiple imputation and FIML methodology, which allowed us to use all available information without the need of listwise deletion of participants with missing values in single variables. Regarding selection bias, in our sample, less mothers showed limited HL compared to a sample from the general population in Germany (Schaeffer et al., 2021). This difference can be explained due to the younger age and the high proportion of highly educated women and without migration background in our sample and limits, the generalizability of our findings on the mean level of HL. However, the associations with predictor variables might only be slightly affected by bias. Whereas participants who dropped out during the first year of the study were characterized by

TABLE 3

Results of the Conditional Latent Growth Curve Model of Health Literacy (*N* = 830)[a]

Predictors	Initial Status (Intercept)			Growth (Slope)		
	Coefficient (Standardized)	SE	CI 95%	Coefficient (Standardized)	SE	CI 95%
Personal determinants						
Age	–0.027 (–0.018)	0.071	[–0.166, 0.112]	–0.002 (–0.004)	0.033	[–0.066, 0.062]
Married, living together with husband (ref)						
Unmarried, living together with partner	–0.227 (–0.015)	0.613	[–1.428, 0.974]	0.229 (0.037)	0.284	[–0.326, 0.785]
Living without partner	–0.030 (–0.001)	1.898	[–3.751, 3.690]	0.244 (0.013)	0.874	[–1.468, 1.957]
Migration background	0.009 (0.000)	0.889	[–1.734, 1.751]	–0.276 (–0.032)	0.411	[–1.081, 0.529]
Low education	0.732 (0.029)	1.042	[–1.311, 2.775]	–0.223 (–0.023)	0.482	[–1.168, 0.721]
Medium education (ref)						
High education	2.280 (0.172)*	0.587	[1.129, 3.431]	0.179 (0.034)	0.272	[–0.354, 0.711]
Employment before pregnancy	0.618 (0.021)	1.110	[–1.557, 2.794]	0.952 (0.084)	0.513	[–0.053, 1.956]
Subjective social status	0.780 (0.151)*	0.231	[0.327, 1.233]	–0.023 (–0.011)	0.109	[–0.236, 0.190]
Risk pregnancy	–0.054 (–0.004)	0.579	[–1.188, 1.081]	0.425 (0.081)	0.268	[–0.101, 0.950]
Chronic/severe disease	0.758 (0.058)	0.554	[–0.327, 1.843]	–0.292 (–0.057)	0.260	[–0.802, 0.218]
Underweight[b]	0.304 (0.010)	1.192	[–2.032, 2.640]	–0.249 (–0.020)	0.555	[–1.337, 0.839]
Normal weight[b] (ref)						
Overweight[b]	–1.554 (–0.091)*	0.661	[–2.850, –0.259]	0.789 (0.117)*	0.308	[0.186, 1.392]
Obese[b]	–0.606 (–0.028)	0.865	[–2.301, 1.089]	1.096 (0.129)*	0.401	[0.309, 1.883]
Preterm birth	0.821 (0.044)	0.797	[–0.742, 2.383]	–0.223 (–0.030)	0.369	[–0.947, 0.501]
Low birthweight	–2.764 (–0.106)*	1.092	[–4.904, –0.624]	0.239 (0.023)	0.505	[–0.751, 1.229]
Normal birthweight (ref)						
High birthweight	7.481 (0.091)*	3.182	[1.245, 13.717]	–1.785 (–0.055)	1.454	[–4.634, 1.064]
Child health status	0.053 (0.065)	0.034	[-0.013, 0.119]	-0.003 (-0.008)	0.016	[–0.034, 0.028]
SF-12 Mental Component Summary	0.021 (0.037)	0.031	[–0.040, 0.082]	–0.001 (–0.004)	0.015	[–0.030, 0.028]
SF-12 Physical Component Score	0.035 (0.046)	0.033	[–0.029, 0.099]	0.011 (0.037)	0.015	[–0.019, 0.041]
EBI parental competence	0.051 (0.031)	0.097	[–0.138, 0.240]	–0.034 (–0.052)	0.045	[–0.122, 0.055]
EBI parental bond	–0.424 (–0.231)*	0.097	[–0.614, –0.235]	0.001 (0.001)	0.046	[–0.088, 0.090]
Current smoker	0.849 (0.017)	2.049	[–3.167, 4.864]	0.080 (0.004)	0.962	[–1.805, 1.964]
Former smoker	0.858 (0.067)	0.518	[–0.157, 1.873]	–0.389 (–0.078)	0.243	[–0.865, 0.087]
Non-smoker (ref)						
Alcohol consumption during pregnancy	–3.287 (–0.057)	2.321	[–7.836, 1.262]	0.724 (0.032)	1.088	[–1.409, 2.857]
No daily fruits/vegetables consumption	0.400 (0.032)	0.496	[–0.572, 1.373]	–0.085 (–0.017)	0.233	[–0.541, 0.371]
Situational determinants						
Social support (FSozU)	0.671 (0.047)	0.628	[–0.559, 1.901]	0.212 (0.038)	0.294	[–0.365, 0.788]
Social/ emotional burden	–0.153 (-0.011)	0.667	[–1.460, 1.155]	0.074 (0.013)	0.313	[–0.539, 0.687]
Low no. of different doctors (ref)						
Medium no. of different doctors	–0.852 (–0.064)	0.615	[–2.057, 0.354]	0.094 (0.018)	0.288	[–0.471, 0.659]

TABLE 3 (CONTINUED)

Results of the Conditional Latent Growth Curve Model of Health Literacy (*N* = 830)[a]

Predictors	Initial Status (Intercept)			Growth (Slope)		
	Coefficient (Standardized)	SE	CI 95%	Coefficient (Standardized)	SE	CI 95%
High no. of different doctors	–0.348 (–0.025)	0.675	[–1.671, 0.975]	0.262 (0.048)	0.317	[–0.358, 0.883]
No midwife service	1.714 (0.041)	1.669	[–1.557, 4.984]	0.469 (0.028)	0.768	[–1.036, 1.973]
No psychosocial support services	–0.395 (–0.020)	0.771	[–1.907, 1.117]	–0.054 (–0.007)	0.355	[–0.751, 0.642]
Private health insurance	0.602 (0.035)	0.683	[–0.737, 1.940]	–0.336 (–0.050)	0.482	[–0.953, 0.281]

Note. R^2 for intercept: .165, for slope: .065. CI = confidence interval; EBI = Eltern-Belastungs-Inventar [parenting stress index]; ref = reference; SE = standard error; SF-12 = Short Form-12.
[a]Subgroup of first-time mothers.
[b]Weight status before pregnancy (body mass index: kg/m²).
*p < .05.

variables indicating lower socioeconomic status, HL scores at baseline did not differ between the analysis sample and the total KUNO-Kids sample.

Future studies should consider different trajectories of HL, including more measurement occasions over a longer period. Furthermore, additional or other predictors should be tested as the amount of explained variance in our conditional model was quite small.

CONCLUSION

Our study identified groups of mothers who could benefit from further support in developing HL skills even before childbirth. Strengthening mothers' HL will eventually result in better health outcomes for both the mother and the child and should therefore continue to be a public health goal.

REFERENCES

Albino, J., Tiwari, T., Henderson, W. G., Thomas, J. F., Braun, P. A., & Batliner, T. S. (2018). Parental psychosocial factors and childhood caries prevention: Data from an American Indian population. *Community Dentistry and Oral Epidemiology, 46*(4), 360–368. https://doi.org/10.1111/cdoe.12376 PMID:29637583

Brandmaier, A. M., von Oertzen, T., Ghisletta, P., Lindenberger, U., & Hertzog, C. (2018). Precision, reliability, and effect size of slope variance in latent growth curve models: Implications for statistical power analysis. *Frontiers in Psychology, 9,* 294. https://doi.org/10.3389/fpsyg.2018.00294 PMID:29755377

Brandstetter, S., Atzendorf, J., Seelbach-Göbel, B., Melter, M., Kabesch, M., Apfelbacher, C., & the KUNO-Kids study group. (2020). Sociodemographic factors associated with health literacy in a large sample of mothers of newborn children: Cross-sectional findings from the KUNO-Kids birth cohort study. *European Journal of Pediatrics, 179*(1), 165–169. https://doi.org/10.1007/s00431-019-03483-9 PMID:31659468

Brandstetter, S., Rothfuß, D., Seelbach-Göbel, B., Melter, M., Kabesch, M., Apfelbacher, C., & the KUNO-Kids study group. (2020). Information on, knowledge and utilisation of support services during pregnancy and after childbirth: Cross-sectional analyses of predictors using data from the KUNO-Kids health study. *BMJ Open, 10*(10), e037745. https://doi.org/10.1136/bmjopen-2020-037745 PMID:33109648

Brandstetter, S., Toncheva, A. A., Niggel, J., Wolff, C., Gran, S., Seelbach-Göbel, B., Apfelbacher, C., Melter, M., Kabesch, M., & the KUNO-Kids study group. (2019). KUNO-Kids birth cohort study: Rationale, design, and cohort description. *Molecular and Cellular Pediatrics, 6*(1), 1. https://doi.org/10.1186/s40348-018-0088-z PMID:30627823

Buckman, C., Diaz, A. L., Tumin, D., & Bear, K. (2020). Parity and the Association Between Maternal Sociodemographic Characteristics and Breastfeeding. *Breastfeeding Medicine, 15*(7), 443–452. https://doi.org/10.1089/bfm.2019.0284 PMID:32456452

de Buhr, E., & Tannen, A. (2020). Parental health literacy and health knowledge, behaviours and outcomes in children: A cross-sectional survey. *BMC Public Health, 20*(1), 1096. https://doi.org/10.1186/s12889-020-08881-5 PMID:32660459

Buuren, S., & Groothuis-Oudshoorn, C. (2011). MICE: Multivariate Imputation by Chained Equations in R. Journal of Statistical Software, 45. Advance online publication. https://doi.org/10.18637/jss.v045.i03

Cashin, M., Wroe, J., & Campbell, L. E. (2021). What parents want to know in the first postnatal year: A Delphi consensus study. Child: Care, Health and Development, 47(1), 47–56. https://doi.org/10.1111/cch.12806 PMID:32881020

Centers for Disease Control and Prevention. (2020, September 17). About Adult BMI. National Center for Chronic Disease Prevention and Health Promotion. https://www.cdc.gov/healthyweight/assessing/bmi/adult_bmi/index.html

Cheung, M. W.-L. (2007). Comparison of methods of handling missing time-invariant covariates in latent growth models under the assumption of missing completely at random. *Organizational Research Methods, 10*(4), 609–634. https://doi.org/10.1177/1094428106295499

Curran, P. J., Obeidat, K., & Losardo, D. (2010). Twelve frequently asked questions about growth curve modeling. *Journal of Cognition and Development, 11*(2), 121–136. https://doi.org/10.1080/15248371003699969 PMID:21743795

DeWalt, D. A., & Hink, A. (2009). Health literacy and child health outcomes: A systematic review of the literature. *Pediatrics, 124*(Suppl. 3), S265–S274. https://doi.org/10.1542/peds.2009-1162B PMID:19861480

Edwards, M., Wood, F., Davies, M., & Edwards, A. (2012). The development of health literacy in patients with a long-term health condition: The health literacy pathway model. *BMC Public Health, 12,* 130. https://doi.org/10.1186/1471-2458-12-130 PMID:22332990

von Elm, E., Altman, D. G., Egger, M., Pocock, S. J., Gøtzsche, P. C., Vandenbroucke, J. P., & the STROBE Initiative. (2007). The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: Guidelines for reporting observational studies. *Lancet, 370*(9596), 1453–1457. https://doi.org/10.1016/S0140-6736(07)61602-X PMID:18064739

Firmino, R. T., Ferreira, F. M., Martins, C. C., Granville-Garcia, A. F., Fraiz, F. C., & Paiva, S. M. (2018). Is parental oral health literacy a predictor of children's oral health outcomes? Systematic review of the literature. *International Journal of Paediatric Dentistry, 28,* 459–471. Advance online publication. https://doi.org/10.1111/ipd.12378 PMID:29984431

Fydrich, T., Sommer, G., & Brähler, E. (2007). Social support questionnaire (F-SozU): Manual [F-SozU. Social Support Questionnaire - Manual]. Hogrefe.

Garcia-Codina, O., Juvinyà-Canal, D., Amil-Bujan, P., Bertran-Noguer, C., González-Mestre, M. A., Masachs-Fatjo, E., Santaeugènia, S. J., Magrinyà-Rull, P., & Saltó-Cerezuela, E. (2019). Determinants of health literacy in the general population: Results of the Catalan health survey. *BMC Public Health, 19,* 1122. Advance online publication. https://doi.org/10.1186/s12889-019-7381-1 PMID:31420029

Ha, A. S., Chan, W., & Ng, J. Y. Y. (2020). Relation between perceived barrier profiles, physical literacy, motivation and physical activity behaviors among parents with a young child. *International Journal of Environmental Research and Public Health, 17*(12), 4459. https://doi.org/10.3390/ijerph17124459 PMID:32575873

Hackman, N. M., Schaefer, E. W., Beiler, J. S., Rose, C. M., & Paul, I. M. (2015). Breastfeeding outcome comparison by parity. *Breastfeeding Medicine, 10*(3), 156–162. https://doi.org/10.1089/bfm.2014.0119 PMID:25549051

Heerman, W. J., Perrin, E. M., Yin, H. S., Sanders, L. M., Eden, S. K., Shintani, A., Coyne-Beasley, T., Bronaugh, A. B., Barkin, S. L., & Rothman, R. L. (2014). Health literacy and injury prevention behaviors among caregivers of infants. *American Journal of Preventive Medicine, 46*(5), 449–456. https://doi.org/10.1016/j.amepre.2014.01.005 PMID:24745634

Hersh, L., Salzman, B., & Snyderman, D. (2015). Health Literacy in Primary Care Practice. *American Family Physician, 92*(2), 118–124. PMID:26176370

Hoebel, J., Müters, S., Kuntz, B., Lange, C., & Lampert, T. (2015). Messung des subjektiven sozialen Status in der Gesundheitsforschung mit einer deutschen Version der MacArthur Scale. [Measuring subjective social status in health research with a German version of the MacArthur Scale]. *Bundesgesundheitsblatt, Gesundheitsforschung, Gesundheitsschutz, 58*(7), 749–757. https://doi.org/10.1007/s00103-015-2166-x PMID:25986532

Hu, L., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling, 6*(1), 1–55. https://doi.org/10.1080/10705519909540118

Kampouroglou, G., Velonaki, V.-S., Pavlopoulou, I. D., Kosmopoulos, M., Kouvas, N., Drakou, E., Skoutelis, N., Spinos, D., Tsagkaris, S., & Tsoumakas, K. (2021). Health literacy of parents/caregivers of paediatric surgical patients: A study on 1000 individuals. African Journal of Paediatric Surgery: AJPS, 18(2), 85–89. https://doi.org/10.4103/ajps.AJPS_42_20 PMID:33642404

Khan, A., Spector, N. D., Baird, J. D., Ashland, M., Starmer, A. J., Rosenbluth, G., Garcia, B. M., Litterer, K. P., Rogers, J. E., Dalal, A. K., Lipsitz, S., Yoon, C. S., Zigmont, K. R., Guiot, A., O'Toole, J. K., Patel, A., Bismilla, Z., Coffey, M., Langrish, K., . . . Landrigan, C. P. (2018). Patient safety after implementation of a coproduced family centered communication programme: Multicenter before and after intervention study. BMJ (Clinical Research Ed.), 363, k4764. https://doi.org/10.1136/bmj.k4764 PMID:30518517

Kim, M., Hsu, H.-Y., Kwok, O. M., & Seo, S. (2018). The optimal starting model to search for the accurate growth trajectory in latent growth models. *Frontiers in Psychology, 9,* 349. https://doi.org/10.3389/fpsyg.2018.00349 PMID:29636712

Kline, R. B. (2016). *Principles and practice of structural equation modeling* (4th ed.). The Guilford Press.

Lagerberg, D., & Magnusson, M. (2013). Utilization of child health services, stress, social support and child characteristics in primiparous and multiparous mothers of 18-month-old children. *Scandinavian Journal of Public Health, 41*(4), 374–383. https://doi.org/10.1177/1403494813484397 PMID:23563993

Maindal, H. T., & Aagaard-Hansen, J. (2020). Health literacy meets the life-course perspective: Towards a conceptual framework. *Global Health Action, 13*(1), 1775063. https://doi.org/10.1080/16549716.2020.1775063 PMID:32588781

Melwani, S., Cleland, V., Patterson, K., & Nash, R. (2022). A scoping review: Global health literacy interventions for pregnant women and mothers with young children. *Health Promotion International, 37*(2), daab047. https://doi.org/10.1093/heapro/daab047 PMID:34269394

Morrison, A. K., Glick, A., & Yin, H. S. (2019). Health Literacy: Implications for Child Health. *Pediatrics in Review, 40*(6), 263–277. https://doi.org/10.1542/pir.2018-0027 PMID:31152099

Morrison, A. K., Myrvik, M. P., Brousseau, D. C., Hoffmann, R. G., & Stanley, R. M. (2013). The relationship between parent health literacy and pediatric emergency department utilization: A systematic review. *Academic Pediatrics, 13*(5), 421–429. https://doi.org/10.1016/j.acap.2013.03.001 PMID:23680294

Nawabi, F., Krebs, F., Vennedey, V., Shukri, A., Lorenz, L., & Stock, S. (2021). Health literacy in pregnant women: A systematic review. *International Journal of Environmental Research and Public Health, 18*(7), 3847. Advance online publication. https://doi.org/10.3390/ijerph18073847 PMID:33917631

Pawellek, M., & Brandstetter, S. (2021, May 31). *A longitudinal analysis of health literacy in new mothers*. https://osf.io/x2zut

Pawellek, M., Kopf, F. M., Egger, N., Dresch, C., Matterne, U., & Brandstetter, S. (2022). Pathways linking parental health literacy with health behaviours directed at the child: A scoping review. *Health Promotion International, 37*(2), daab154. https://doi.org/10.1093/heapro/daab154 PMID:34668013

Peyton, D., Hiscock, H., & Sciberras, E. (2019). Do digital health interventions improve mental health literacy or help-seeking among parents of children aged 2-12 years? A scoping review. *Studies in Health Technology and Informatics, 266,* 156–161. https://doi.org/10.3233/SHTI190788 PMID:31397317

Rosseel, Y. (2012). lavaan: An R package for structural equation modeling. *Journal of Statistical Software, 48*(2). Advance online publication. https://doi.org/10.18637/jss.v048.i02

Schaeffer, D., Berens, E.-M., Gille, S., Griese, L., Klinger, J., de Sombre, S., Vogt, D., & Hurrelmann, K. (2021). Gesundheitskompetenz der Bevölkerung in Deutschland vor und während der Corona Pandemie: Ergebnisse des HLS-GER 2 [Health literacy in the German population before and during the Corona pandemic: results of HLS-GER 2]. https://doi.org/10.4119/UNIBI/2950305

Schaeffer, D., Berens, E.-M., & Vogt, D. (2017). Health literacy in the German population. *Deutsches Ärzteblatt International, 114*(4), 53–60. https://doi.org/10.3238/arztebl.2017.0053 PMID:28211318

Schaeffer, D., & Hurrelmann, K. (2018). Bauer, Ullrich, Kolpatzik, Kai. National Action Plan Health Literacy. Promoting Health Literacy in Germany. KomPart.

Schaeffer, D., Vogt, D., Berens, E.-M., & Hurrelmann, K. (2016). Gesundheitskompetenz der Bevölkerung in Deutschland - Ergebnisbericht [Health literacy in the German population - result report]. Universität Bielefeld, Fakultät für Gesundheitswissenschaften. https://doi.org/10.2390/0070-pub-29088450

Sørensen, K., Van den Broucke, S., Fullam, J., Doyle, G., Pelikan, J., Slonska, Z., Brand, H., & the (HLS-EU) Consortium Health Literacy Project European. (2012). Health literacy and public health: A systematic review and integration of definitions and models. *BMC Public Health, 12,* 80. https://doi.org/10.1186/1471-2458-12-80 PMID:22276600

Sørensen, K., Van den Broucke, S., Pelikan, J. M., Fullam, J., Doyle, G., Slonska, Z., Kondilis, B., Stoffels, V., Osborne, R. H., Brand, H., & the HLS-EU Consortium. (2013). Measuring health literacy in populations: Illuminating the design and development process of the European Health Literacy Survey Questionnaire (HLS-EU-Q). *BMC Public Health, 13,* 948. https://doi.org/10.1186/1471-2458-13-948 PMID:24112855

Svendsen, M. T., Bak, C. K., Sørensen, K., Pelikan, J., Riddersholm, S. J., Skals, R. K., Mortensen, R. N., Maindal, H. T., Bøggild, H., Nielsen, G., & Torp-Pedersen, C. (2020). Associations of health literacy with socioeconomic position, health risk behavior, and health status: A large national population-based survey among Danish adults. *BMC Public Health, 20*(1), 565. https://doi.org/10.1186/s12889-020-08498-8 PMID:32345275

Tröster, H. (2010). Eltern-Belastungs-Inventar [parenting stress index]: Manual [EBI. Parenting Stress Index]. Hogrefe.

Tucker, L. R., & Lewis, C. (1973). A reliability coefficient for maximum likelihood factor analysis. *Psychometrika, 38*(1), 1–10. https://doi.org/10.1007/BF02291170

Ware, J., Jr., Kosinski, M., & Keller, S. D. (1996). A 12-Item Short-Form Health Survey: Construction of scales and preliminary tests of reliability and validity. *Medical Care, 34*(3), 220–233. https://doi.org/10.1097/00005650-199603000-00003 PMID:8628042

Yin, H. S., Sanders, L. M., Rothman, R. L., Shustak, R., Eden, S. K., Shintani, A., Cerra, M. E., Cruzatte, E. F., & Perrin, E. M. (2014). Parent health literacy and "obesogenic" feeding and physical activity-related infant care behaviors. *The Journal of Pediatrics, 164*(3), 577–583.e1. https://doi.org/10.1016/j.jpeds.2013.11.014 PMID:24370343

Table A: Detailed information about predictor variables

PERSONAL DETERMINANTS	
Sociodemographic variables	
Mothers' age	years
Marital status	married and living together unmarried and living together living without partner
Country of birth	Germany other
Education	less than 10 years of schooling 10 years of schooling more than 10 years of schooling
Employment before pregnancy	yes no
Number of children	one more
Subjective social status	German version of MacArthur scale (Hoebel et al., 2015): 0 - 10
Health variables	
Self-reported risk pregnancy	yes no
History of any chronic or severe disease	yes no *Chronic diseases: allergic rhinitis/conjunctivitis, bronchial asthma, asthmatic obstructive bronchitis, eczema, celiac disease, Crohn's disease, ulcerative colitis, psoriasis, psoriatic arthritis, rheumatoid arthritis, other autoimmune disease, type I/type II diabetes mellitus, liver disease, kidney disease, thyroid disease, cancer, cardiac arrhythmias, heart attack, heart failure/insufficiency, hypertonus, other metabolic diseases, ADD/ADHD, depression, anorexia, bulimia, migraine, anxiety or panic disorder, multiple sclerosis, epilepsy*
Mother's weight status before pregnancy	BMI: kg/ m² (Centers for Disease Control and Prevention [CDC], 2020) underweight normal weight overweight obese
Gestational age	< 38 weeks ≥ 38 weeks of pregnancy
Child birth weight	<2500g 2500 – 4500g >4500g
Subjective health status	Visual analogue scale: 0 – 100
Psychosocial variables	

Mother's health-related quality of life regarding mental and physical health	mental component summary scale and physical component summary scale of the standardized questionnaire SF-12 (Short Form-12 Questionnaire; Ware et al., 1996))
Parental competences and parenting stress regarding parent-child bond	German version of the Parenting Stress Index ("Eltern-Belastungs-Inventar", EBI; Tröster, 2010)
Health (risk) behaviours	
Smoking	current former never
Alcohol consumption during pregnancy	yes no
Fruits or vegetables consumption during pregnancy	almost daily less than almost daily
SITUATIONAL DETERMINANTS	
Social support	standardized questionnaire F-SozU K-14 (Fydrich et al., 2007)
Social or emotional burden	yes no
Interaction health system	
Number of different doctors visited during pregnancy in addition to obstetrician/gynaecologist	categorised into tertiles
Utilisation of midwife services	yes no
Utilisation of psychosocial support services	yes no
Health insurance status	statutory private

Table B: STROBE Statement: checklist for cohort studies

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	1
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	1-3
Objectives	3	State specific objectives, including any prespecified hypotheses	3
Methods			
Study design	4	Present key elements of study design early in the paper	3
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	3
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	3
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed	-
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	3
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	3, Table A
Bias	9	Describe any efforts to address potential sources of bias	3-4, Table C
Study size	10	Explain how the study size was arrived at	3-4, Figure 2
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	3-4

Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	3-4
		(*b*) Describe any methods used to examine subgroups and interactions	3-4
		(*c*) Explain how missing data were addressed	3-4
		(*d*) If applicable, explain how loss to follow-up was addressed	-
		(*e*) Describe any sensitivity analyses	-
Results			
Participants	13*	(*a*) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	5, Figure 2
		(*b*) Give reasons for non-participation at each stage	Figure 2
		(*c*) Consider use of a flow diagram	Figure 2
Descriptive data	14*	(*a*) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	5, Table 1
		(*b*) Indicate number of participants with missing data for each variable of interest	Table 1
		(*c*) Summarise follow-up time (eg, average and total amount)	-
Outcome data	15*	Report numbers of outcome events or summary measures over time	5
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	5, Table 2, Table D
		(*b*) Report category boundaries when continuous variables were categorized	5, Table 1
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	-

Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	5-6, Table 3, Table E
Discussion			
Key results	18	Summarise key results with reference to study objectives	6
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	9, 11
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	7, 9
Generalisability	21	Discuss the generalisability (external validity) of the study results	11
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	2

Table C: General characteristics and HL scores at baseline of participants who were included (analysis sample) and not included (drop-out sample), total KUNO-Kids sample N = 2685

	N^a (analysis sample, N^a= 1363)			N^b (drop-out sample, N^b= 1322)		
	N	**n (%)**	**Mean (SD)**	**N**	**n (%)**	**Mean (SD)**
Age (years)	1351		32.62 (4.15)	1306		31.75 (4.80)
Marital status	1339			1274		
Married, living together with husband		1101 (82.2%)			946 (71.6%)	
Unmarried, living together with partner		215 (16.1%)			282 (21.3%)	
Living without partner/ divorced/ widowed		23 (1.7%)			46 (3.5%)	
Migration background (country of birth Germany)	1341	1209 (90.2%)		1274	1012 (76.6%)	
Maternal education	1336			1260		
No degree or less than 10 years of schooling		91 (6.8%)			201 (15.2%)	
Ten years of schooling		407 (30.5%)			424 (32.1%)	
University entrance level		838 (62.7%)			635 (48%)	
Maternal employment before pregnancy	1337	1211 (90.6%)		1271	1075 (81.3%)	
Primiparous	1352	830 (61.4%)		1290	659 (49.8%)	
Subjective social status	1213		6.72 (1.24)	503		6.70 (1.34)
Health literacy *(HLS-EU health care scale)*						
Baseline	1363		35.46 (7.34)	1202		35.65 (7.31)

N^a: analysis sample, N^b: drop-out sample, SD: standard deviation

Table D: Results of the unconditional latent growth curve model for HL (total analysis sample, N = 1363)

	Estimate (standardized)	SE	95% CI	p
Intercept mean	35.687 (5.714)	0.195	35.304 – 36.069	< .001
Intercept variance	39.000 (1)	2.254	34.583 – 43.418	< .001
Slope mean	1.188 (0.487)	0.087	1.017 – 1.358	< .001
Slope variance	5.950 (1)	0.894	4.197 – 7.703	< .001
Residual variance HL1	14.953 (0.277)	1.791	11.442 – 18.464	< .001
Residual variance HL2	14.311 (0.267)	0.951	12.448 – 16.174	< .001
Residual variance HL3	3.448 (0.063)	1.762	-0.006 – 6.902	.05
Covariance	-2.850 (-0.187)	0.976	-4.763 – -0.938	.003

SE: standard error, CI: confidence interval, HL1: Health literacy at baseline after child birth, HL2: Health literacy after 6 months, HL3: Health literacy after 12 months

Model fit: χ^2 (1) = 23.823 (p < .001), CFI = .989, TLI = .968, RMSEA = .129 (90% CI: .088–.177), SRMR = .022

Table E: Results of the unconditional latent growth curve model for HL (subgroup of first-time mothers, N = 830)

	Estimate (standardized)	**SE**	**95% CI**	**p**
Intercept mean	35.239 (5.537)	0.254	34.741 – 35.737	< .001
Intercept variance	40.502 (1)	2.971	34.679 – 46.325	< .001
Slope mean	1.357 (0.531)	0.113	1.136 – 1.578	< .001
Slope variance	6.531 (1)	1.157	4.263 – 8.799	< .001
Residual variance HL1	14.998 (0.270)	2.341	10.410 – 19.585	< .001
Residual variance HL2	14.759 (0.271)	1.240	12.328 – 17.189	< .001
Residual variance HL3	2.354 (0.043)	2.263	-2.081 – 6.790	.298
Covariance	-3.630 (-0.223)	1.270	-6.119 – -1.142	.004

SE: standard error, CI: confidence interval, HL1: Health literacy at baseline after child birth, HL2: Health literacy after 6 months, HL3: Health literacy after 12 months

Model fit: χ^2 (1) = 16.946 ($p < .001$), CFI = .988, TLI = .964, RMSEA = .139 (90% CI: .086–.200), SRMR = .024

ECR (effective curve reliability): .77