

*Article*

---

**Digital Motherhood**

DOI: 10.47368/ejhc.2022.304

2022, Vol. 3(3) 69-91

CC BY 4.0

**Self-Tracking Apps for Breastfeeding  
Mothers—A Study on Usage and Effects on  
Maternal Well-Being****Nariman Sawalha** 

Department of Communication Studies and Media Research, LMU Munich, Germany

**Veronika Karnowski** 

Seminar of Media and Communication Studies, University of Erfurt, Germany

**Abstract**

Smartphone apps for self-tracking breastfeeding emerged as a popular tool among new mothers. Yet, we know little about how mothers use these apps and, most importantly, how self-tracking breastfeeding relates to maternal well-being. After surveying a sample of German mothers engaging with breastfeeding trackers (n = 234; recruited via an online access panel), we identified three types of self-tracking usage: (1) straightforward basic trackers, (2) meticulous data collectors, and (3) advisory-oriented self-trackers. These usage types differ regarding the data they register, the algorithmic feedback they retrieve, and their conversational levels about parameters tracked. Our findings suggest that overall maternal well-being – in terms of confidence, stress, and self-worth – remains largely unaffected by different self-tracking usage. However, when considering only the mothers' confidence concerning breastfeeding, breastfeeding self-efficacy is lower among those most engaged in tracking and higher among those least engaged with it. Implications of these findings are discussed in terms of whether breastfeeding trackers enhance or undermine mothers' confidence in their breastfeeding abilities relative to the intensity of their self-tracking use. Thus, future research may include longitudinal designs to validate these findings and derive effective app-supported smartphone interventions for breastfeeding mothers.

**Keywords**

Self-tracking, breastfeeding, maternal well-being, digital motherhood, mHealth.

---

**Corresponding author:**

Nariman Sawalha: nariman.sawalha@ifkw.lmu.de

The World Health Organisation (WHO, 2017) recommends exclusively breastfeeding babies for the first six months of their lives. Both in the short- and long-term, breastfeeding has several proven beneficial effects on infants' health. It decreases infant mortality and morbidity, strengthens the child's immune system, and lowers the risk of Type 2 diabetes and high blood pressure later in life (Horta & Victora, 2013a & b). Likewise, mothers have a decreased risk to suffer from certain types of cancer and Type 2 diabetes (Schwarz & Nothnagle, 2015). Still, only two-thirds (68%) of mothers in Germany exclusively breastfeed postpartum, dropping to 40% in the fourth and as low as 16% in the sixth month of their babies' lives (Brettschneider et al., 2018). Furthermore, initiation and duration of breastfeeding is particularly challenging for mothers struggling with delayed milk supply after caesarean section or preterm delivery, often precipitating premature weaning (Alves et al., 2016; Hobbs et al., 2016). Given this trend, scholars suspect insufficient breastfeeding promotion and scarce health education within the healthcare system (e.g., Roll & Cheater, 2016).

To compensate for this lack of support, self-tracking apps emerged as a popular tool among breastfeeding mothers (Virani et al., 2019). Through tracked data, such as the time, length, or side of feed, self-tracking systems can guide mothers in establishing a mindful breastfeeding routine, which may result in improved breastfeeding efficacy and duration (Dienelt et al., 2020). A literature review by Lupton et al. (2016) revealed that mothers find a source of reassurance in digital media that alleviates feelings of uncertainty and self-doubt. On the downside, interviews with self-tracking mothers have pointed to undesired consequences, including neglecting maternal subjectivity and an overreliance on the device (e.g., Thornham, 2019).

To further unpack these contradictory views on mothers' self-tracking breastfeeding, we aim to examine German mothers' varying engagement with self-tracking apps for breastfeeding purposes to identify different usage types and how they relate to maternal well-being in terms of confidence, stress, and self-worth. Finally, we also consider mothers' overall smartphone attachment (Ross & Bayer, 2021) and its interrelations with the above-mentioned usage types.

### *Mothers' Use of Digital Media*

Transitioning to motherhood entails deep-reaching physical, mental, and social changes, along with feelings of uncertainty, anxiety, and isolation (Plantin & Daneback, 2009). Meanwhile, healthcare services often do not meet women's increased need for information and reassurance (Cannon et al., 2018). An international survey, including primarily Western countries, on information seeking during pregnancy, found that approximately half (48.6%) of pregnant women surveyed were dissatisfied with prenatal care visits (Lagan et al., 2010). Thus, due to their ready accessibility, digital media became an integral part of motherhood in the global North (Lupton et al., 2016). Moreover, recent studies in Asia (e.g., Jayaseelan et al., 2015; Wang et al., 2018), Africa (e.g., Flax et al., 2014; Trafford et al., 2020), and South America (e.g., Quintiliano-Scarpelli et al. 2021; Silva et al., 2019) suggest a similar pattern, indicating a cross-cultural trend toward digitally mediated motherhood on a global scale. As early as the mid-1990s, various websites, discussion forums, and so-called 'mommy blogs' provided (expectant) mothers with advice, social support, and an outlet to voice their experiences (Thomas & Lupton, 2016). While these sources are still in use today (Jaks et al., 2019), recent research has shown a notably high uptake of maternity apps for pregnancy- and parenting-related information seeking (Kraschnewski et al., 2014). According to data from *Listening to*

*Mothers III*, a large-scale survey conducted in the U.S., more than half (56%) of first-time mothers and nearly half (47%) of experienced mothers rated apps with pregnancy and childbirth information as “very valuable” (Declercq et al., 2013). Similar figures apply for pregnant women in an Irish study (59%), which also reported common use among educationally disadvantaged women (48%; O’Higgins et al., 2014). Baby care apps are especially valued for their novel functionalities, namely self-tracking functions (Hughson et al., 2018). These range from monitoring fertility and foetal growth to tracking the infant’s development, sleeping patterns, and feeding habits – covering every stage of early motherhood (Lupton et al., 2016). Given the complexity of nursing alone, breastfeeding apps with tracking components attracted particular attention from both medical research (e.g., Demirci & Bogen, 2017; Griffin et al., 2021; Wang et al., 2017; Wheaton et al., 2018) and social sciences (e.g., Dienelt et al., 2020; Lupton, 2017; Thornham, 2019). With functions such as customisation, reminders, visualisation of progress, and synchronisation to wearables and smart devices, self-tracking apps are expected to ease mothers into mindful and efficient breastfeeding routines (Virani et al., 2019). Still, not all maternal app use turns out favourable. Some perceive mobile monitoring of breastfeeding as a time-consuming task that is incompatible with the day-to-day life of a new mother (Demirci & Bogen, 2017). Complicating matters further, prior research alerts about an excessive dependency on tracking devices that can suppress the development of own maternal capabilities (Thornham, 2019). This ambivalent study situation highlights the underlying mental health-related consequences of self-tracking use. Consequently, a thorough investigation into usage types will help us uncover the potential advantages and disadvantages associated with self-tracking breastfeeding.

### *Conceptualisation of Self-Tracking Usage*

To identify differences in self-tracking usage among breastfeeding mothers, we draw on Lomborg et al.’s (2018) conceptualisation of self-tracking. Fundamentally, self-tracking is understood as a notion of *flow*: A user tracks personal data and logs it into the system, the system processes the data and transmits it back to the user, ultimately allowing her “to sift through everyday life and extract habitual and meaningful practices” (Thylstrup & Lomborg, 2017, p. 1). Considering this interplay between system and user, there are varying modes of engagement with the technology. These can be categorised into registration, algorithmic feedback, and conversation (see Karnowski & Reifegerste) and will be defined below in reference to breastfeeding trackers.

*Registration* covers the basics of self-tracking, where information about the user is logged into the system. This step happens either manually (user-initiated) or automatically (system-monitored, i.e., through sensors on the device). The user’s aim might be to increase self-awareness through quantified parameters, generating consciousness about what Lupton (2014) calls “the hidden patterns in one’s life that are otherwise undiscernible” (p. 13). Hence, already the simple act of taking notes – i.e., of time between feeds, length of feed, side of feed, or amount fed – in itself imparts knowledge about relevant details to observe when nursing (Dienelt et al., 2020).

*Algorithmic feedback* comprises two data-driven features of self-tracking regimens: allocation and consultation (see also Karnowski & Reifegerste, 2021). As a system-initiated mechanism, allocation initially keeps users “on track” by reminding them to register data in-between tracking sessions. For instance, breastfeeding apps send push messages to offer

general advice (e.g., “5 signs your baby is hungry”) or to prompt users to breastfeed in time (e.g., “It’s time to breastfeed your baby!”; Hughson et al., 2018). These are either default recommendations set by the system or personalised reminders configured by the user. Consultation takes feedback communication a step further. Through an analysis of accumulated data, the system allows users to discover patterns, trends, or progress in past tracking experiences. For this purpose, the collected data is often presented in visualisations, statistics, or explicit messages (Karnowski & Reifegerste, 2021). Hence, this tool is convenient to retrace breastfeeding habits. One option for this is to compare previous with current data (historical comparison); another option juxtaposes the users’ data and a defined goal (normative comparison; Hermsen et al., 2016). In addition, maternal apps often incorporate reward systems or gamification elements (Lupton & Thomas, 2019).

*Conversation*, as a third mode of engagement with self-tracking technology, describes the user-initiated distribution and sharing of data with others. This distribution and sharing can occur directly within the app, via social networking sites, or face-to-face. In many instances, conversations serve the purpose of gaining support and validation. Therefore, mothers not only share and discuss their data with other app users but also incorporate it in medical appointments to demonstrate their maternal skills (Thornham, 2019).

To determine differences in individual self-tracking usage among breastfeeding mothers, we proceed from this conceptualisation and ask:

*RQ1:* Which types of self-tracking usage can be identified among breastfeeding mothers regarding users’ engagement with registration, algorithmic feedback, and conversation?

### *Psychological Dimension of Mobile Device Use*

One often neglected aspect in examining users’ engagement with self-tracking technology is the overall relationship between the user and her smartphone. Therefore, we will also consider the concept of *smartphone self-extension* (Park & Kaye, 2018). In principle, self-extension describes how material objects, i.e., smartphones or wearables, are perceived as an integral part of one’s body or an extension of the self (Belk, 1988; Ross & Bayer, 2021). This embodiment of devices can shape how a person thinks or feels (Ross & Campbell, 2021). Ross & Bayer (2021) differentiate two dimensions of smartphone self-extension. *Functional* self-extension refers to the outsourcing and also the expansion of human (intellectual) capabilities (e.g., count number of steps). *Identity* self-extension concerns the appropriation of the smartphone to create one’s sense of self – whether it is the customisation of the device to reflect the user’s self, or even more blatant, the ‘fusing’ of the user with her device to the extent that smartphone use becomes existential to one’s identity.

Complementing the identification of self-tracking usage types among breastfeeding mothers, we want to take a closer look at users’ connectedness to their smartphones:

*RQ2:* How do the identified types of self-tracking usage among breastfeeding mothers differ with regard to users’ level of both functional and identity smartphone self-extension?

### *Self-Tracking and Maternal Well-Being*

Maternal engagement in self-tracking can be seen as a liberating practise: It helps mothers understand their bodies’ and their infants’ cues and guides them through an otherwise stressful and emotionally challenging stage of life (Byrt & Dempsey, 2020). Correspondingly, self-

tracking is associated with building *maternal confidence* (e.g., Gibson & Hanson, 2013). Mothers in Dienelt et al.'s (2020) qualitative survey expressed their appreciation for infant feeding trackers, especially in gaining some sense of confidence, mastery, and control. Affirmative algorithmic feedback conveys the certainty of “doing okay” (Thornham, 2019, p. 176). This sort of empowerment also improves breastfeeding efficacy (Dienelt et al., 2020). Accordingly, studies find enhanced intentions for breastfeeding exclusivity and duration following mobile health (mHealth) interventions (Ahmed et al., 2016; Litterbach et al., 2017). Nonetheless, there is no clear evidence that technically more advanced mHealth systems with interactive features lead to more promising breastfeeding rates than simple digital breastfeeding handouts (Griffin et al., 2021; Lewkowitz et al., 2020).

Breastfeeding, however, is not just a matter of willingness but largely depends on physiological factors (e.g., milk supply, mastitis) and, of course, on how well the baby cooperates (Awaliyah et al., 2019). Thus, self-tracking apps may cause frustration and annoyance if users cannot reach set goals (Costa Figueiredo et al., 2018). Contrary to the promised relief from worries (Johnson, 2014), scholars point to the risk of reinforced maternal stress (Demirci & Bogen, 2019). According to Sanders (2017), anxiety-provoking self-tracking experiences originate from the “sense of constant visibility” (p. 53). In the case of new mothers, this could be the fear of not meeting the socially imposed normative ideals of “good motherhood” (Thornham, 2019, p. 177). Here, critics raise concerns about datafication (van Dijck, 2014), an overreliance on quantified parameters. This trap of dataism may misguide women to perceive tracked data as more accurate and reliable than their own maternal subjectivity (Thornham, 2019). For instance, interviewed women repeatedly described situations in which they first grabbed the tracking device before latching on their crying baby for feeding (Dienelt et al., 2020; Thornham, 2019). In this case, self-tracking might create an illusion of control and inhibits actual maternal enjoyment (Sharon, 2017).

Considering the normative nature of self-tracking, users are constantly confronted with their maternal performance (Johnson, 2014). This constant confrontation inevitably affects feelings of self-worth, especially at a highly sensitive time like the breastfeeding period (Lupton et al., 2016). Accordingly, Knittel et al. (2018) suggest that positive or negative feelings about data outcomes can boost or harm users' self-esteem. Here, it is worth noting that (breastfeeding) mothers' appreciation of the body and its functionality has fundamental associations with self-esteem (Hutchison & Cassidy, 2021; Rosenbaum et al., 2020). Furthermore, as Johnson (2014) posits, mothers could attain feelings of self-worth by sharing their maternal experience and images of their babies (as “the mother's work” (p. 337)) on digital media. However, empirical evidence on how maternal self-worth projects through conversations or self-tracking remains scant.

To investigate maternal well-being with respect to breastfeeding mothers' engagement with self-tracking technology, we hence ask:

*RQ3:* How do the identified types of self-tracking usage among breastfeeding mothers differ with regard to the users' maternal well-being relating to confidence, stress, and self-worth?

## Method

Building on related work using a qualitative approach (e.g., Dienelt et al., 2020; Lupton, 2017; Thornham, 2019), we set out to quantify the research problem. Since the identification of usage types (*RQ1*) requires precise descriptive answers to the questions “how many?”, “how much?”, and “how often?”, a standardised questionnaire represents an adequate approach (Amaratunga et al., 2002; Mulisa, 2021). The logic of typological data then allows uncovering the similarities and differences of said usage types on smartphone self-extension (*RQ2*) and maternal well-being (*RQ3*). Hence, we conducted an online survey among German mothers (18 to 44 years) who have breastfed in the last 12 months and have used mobile self-tracking apps to monitor breastfeeding. Mothers for our sample were invited via an online access panel by Bilendi, which contacted 4241 women aged 18 to 44 with a child aged up to 24 months. Bilendi paid each participant €1.00 to complete the survey. The study was carried out in September 2021 on the survey platform SoSci survey. Data analysis was performed using R.

### Measures<sup>1</sup>

**Modes of Self-Tracking.** To assess participants’ engagement with self-tracking systems, according to Lomborg et al. (2018), we followed Karnowski and Reifegerste’s (2021) adaption and further customised it to apply to breastfeeding tracking. For *registration*, we asked participants to specify which parameters (respectively time, length, and amount of breastfeeding, pumping, and bottle feeding) they tracked how often and which device(s) they used to log information. We determined the forms of *algorithmic feedback* participants retrieved through the specifications general advice, visualisations, personalised advice, and rewards. Additionally, we asked if they received these as push messages. Concerning personalised advice (e.g., “It’s time to breastfeed your baby”), participants were requested to state whether they self-adjust these or if they also make use of the apps’ default recommendations. Acts of *conversation* were measured by the frequency in which users discussed their self-tracked data within the app, on social media, or face-to-face with family and friends and in medical appointments, e.g., with a midwife. We also assessed how participants first became aware of the app.

**Smartphone Self-Extension.** We measured both functional and identity smartphone self-extension using Ross and Bayer’s 12-item smartphone Self-extension Scale (2021; scale from 1 = *does not apply at all* to 5 = *fully applies*, intermediate points labelled).

**Maternal Well-Being.** To determine *maternal confidence*, we put three measures to use: First, in terms of specific breastfeeding confidence, we used the short 14-item breastfeeding Self-Efficacy Scale (Dennis, 2003; e.g.: “I can always tell when my baby is finished breastfeeding.”; scale from 1 = *does not apply at all* to 5 = *fully applies*, endpoints labelled) and the Breastfeeding Motivation Scale (Kestler-Peleg et al., 2015; e.g.: “I am

Table 1. Parameters of Indices

Indices	Number of Items	<i>M</i>	<i>SD</i>	Cronbach's Alpha
<b>Dimension of mobile psychology</b>				
<b>Smartphone self-extension</b>				
Functional self-extension	6	3.8	0.6	.74
Identity self-extension	6	2.0	1.0	.91
<b>Maternal mental well-being</b>				
<b>Maternal confidence</b>				
Breastfeeding self-efficacy	14	4.0	0.8	.91
Breastfeeding motivation	24	3.5	0.7	.90
Maternal experience	13	2.9	0.5	.80
<b>Maternal stress</b>				
Perceived stress	10	3.0	0.7	.84
<b>Maternal self-worth</b>				
Self-esteem	10	3.8	0.8	.89
Body appreciation	10	3.4	0.8	.94

breastfeeding because I feel proud and important while breastfeeding.”; 24 items, scale from 1 = *strongly disagree* to 5 = *strongly agree*, intermediate points labelled) that allowed us to assess both the level of skill as well as willingness concerning mothers' perceptions in their breastfeeding abilities. In addition, we assessed overall maternal experience – outside of breastfeeding obligations – with the Being a Mother Scale (Matthey, 2010; e.g.: “I have felt confident about looking after my baby/toddler.”; 13 items, scale from 1 = *never* to 5 = *always*, intermediate points labelled). According to previous studies, we captured *maternal stress* using the Perceived Stress Scale, which indicates the level of stress during the last month (Cohen et al., 1983, p. 394; Schneider et al., 2020; e.g.: “In the last month, how often have you felt nervous and ‘stressed’?”; 10 items, scale from 1 = *never* to 5 = *very often*, endpoints labelled). *Maternal self-worth* was based on the Rosenberg Self-Esteem Scale (Rosenberg, 1965; von Collani & Herzberg, 2008; e.g.: “I certainly feel useless at times.”; 10 items, scale from 1 = *does not apply at all* to 5 = *fully applies*, intermediate points labelled) and the Body Appreciation Scale-2 (Tylka & Wood-Barcalow, 2015; e.g.: “I respect my body.”; 10 items, scale from 1 = *never* to 5 = *always*, intermediate points labelled), with which we gauged attitudes towards both one's inner self and outer appearance. An overview of descriptive statistics and reliability measures is presented in Table 1.

**Demographic Characteristics.** Finally, respondents' age, educational level, occupation, and family status were assessed. Moreover, we measured specific maternal characteristics like former breastfeeding experience and details on the breastfed child.

### Participants

The recruitment initially resulted in 247 completed interviews, of which 13 had to be excluded, as they did not conform to the quality criteria (e.g., rushed through the questionnaire; Leiner, 2019). Hence, our final sample consists of 234 mothers with an average age of 31.1 years (*SD* = 4.5). 54.3% of respondents have a high, 38.5% middle, and 5.5% low educational level.<sup>2</sup> 61.1% were not employed during their breastfeeding period, 21.8% worked part-time, and

17.1% worked full-time. Almost all of the mothers live in a partnership (96.2%). Regarding specific maternal characteristics, 50% are first-time mothers. Of those women with previous breastfeeding experience (49.1%), 48.4% had used a breastfeeding tracker before. Concerning the birth of the current breastfeeding child, 13.6% of respondents had a premature and 28.6% a caesarean delivery.

## Results

### *Maternal Engagement with Breastfeeding Trackers: A Typology*

Addressing our first research question on different types of self-tracking usage among breastfeeding mothers, we implemented a latent class analysis using R package *poLCA* (v. 1.4.1; Linzer & Lewis, 2011)<sup>3</sup>. To identify clusters of similar usage styles, the three main modes of engagement with self-tracking systems – registration, algorithmic feedback, and conversation – were included. Based on the one- to ten-class-solutions, the three-class-solution represents the best model fit as defined by the Bayesian Information Criterion (BIC, see Table 2), which leaves us with a satisfactory entropy of .93 (Celeux & Soromenho, 1996).

Building on this model, we determined three types of self-tracking usage among breastfeeding mothers, which can be characterised as (1) straightforward basic trackers, (2) meticulous data collectors, and (3) advisory-oriented self-trackers (see Table 3).

*Straightforward basic trackers* make up the biggest group in our sample (43.0%). Mothers in this group are likely to stick to the basics of self-tracking usage on all modes. They appear to register relatively few parameters – mainly time and length of breastfeeding – and they do more sporadically than other users. Like the *meticulous data collectors*, it is improbable that they connect their tracking system to external devices. In line with a fairly basic approach to registration, their employment of algorithmic feedback is rather simplistic. *Straightforward basic trackers* likely access general advice and visualised results. Yet, in all likelihood, they largely avoid more personalised data handling features. Conversational-wise, it is unlikely that mothers in this group share their data within the app or on social media. Nonetheless, discussions about tracked data are more likely in interpersonal settings, at least now and then.

Table 2. Model Fit 1- to-10-Cluster Solutions

Model	Number of Classes	df	BIC
Model 1	1	202	6981.67
Model 2	2	169	6572.15
<b>Model 3</b>	<b>3</b>	<b>136</b>	<b>6486.38</b>
Model 4	4	103	6503.27
Model 5	5	70	6523.76
Model 6	6	37	6618.89
Model 7	7	4	6706.76
Model 8	8	-29	6812.58
Model 9	9	-62	6938.76
Model 10	10	-95	7053.76

Note. Best model fit indicated in bold.



Table 3. 3-Cluster-Solution: Conditional Item Response Probabilities

Items	Straightforward Basic Trackers	Meticulous Data Collectors	Advisory- Oriented Self- Trackers
Relative cluster size	43.0%	35.8%	21.2%
<b>Registration: Parameters tracked</b>			
<i>Breastfeeding</i>			
Time			
(Almost) every time	54.3%	90.3%	61.9%
Occasionally	35.0%	3.5%	34.0%
Never	10.7%	6.2%	4.1%
Length			
(Almost) every time	49.4%	69.2%	53.1%
Occasionally	35.8%	11.7%	42.7%
Never	14.8%	19.1%	4.2%
Amount of milk drunk			
(Almost) every time	4.7%	21.7%	36.4%
Occasionally	7.6%	7.8%	42.0%
Never	87.6%	70.5%	21.6%
<i>Pumping breast milk</i>			
Time			
(Almost) every time	0.7%	73.3%	40.2%
Occasionally	3.9%	6.9%	49.0%
Never	95.5%	19.8%	10.8%
Length			
(Almost) every time	0.9%	42.5%	25.3%
Occasionally	1.1%	8.8%	49.5%
Never	98.0%	48.8%	25.2%
Amount of milk pumped			
(Almost) every time	0.0%	72.1%	37.5%
Occasionally	3.5%	4.7%	53.6%
Never	96.5%	23.2%	8.9%
<i>Bottle-feeding</i>			
Time			
(Almost) every time	2.0%	68.6%	43.3%
Occasionally	19.4%	3.9%	36.8%
Never	78.6%	27.5%	19.9%
Length			
(Almost) every time	0.0%	32.7%	17.3%
Occasionally	9.8%	5.0%	52.2%
Never	90.2%	62.2%	30.5%
Amount of milk drunk from bottle			
(Almost) every time	4.9%	64.9%	35.7%
Occasionally	12.8%	0.0%	42.7%
Never	82.3%	35.1%	21.6%

Table 3. 3-Cluster-Solution: Conditional Item Response Probabilities (continued)

Registration: Device			
On a smartwatch	0.0%	1.2%	14.1%
On a fitness tracker	0.0%	0.0%	8.1%
Algorithmic feedback			
General advice	47.6%	54.0%	60.2%
Visualised results	54.6%	51.7%	62.1%
Personalised advice	13.6%	30.2%	44.5%
Rewards	4.9%	14.1%	34.8%
Conversation			
<i>Within the app</i>			
At least weekly	3.9%	5.9%	34.5%
Several times a month or less	10.2%	10.5%	42.2%
Never	85.8%	83.6%	23.3%
<i>Via social media</i>			
At least weekly	2.9%	5.7%	32.8%
Several times a month or less	11.8%	17.6%	45.1%
Never	85.3%	76.6%	22.1%
<i>Interpersonal with family and friends</i>			
At least weekly	16.7%	36.4%	61.7%
Several times a month or less	41.4%	47.0%	38.3%
Never	25.9%	16.7%	0.0%
<i>Interpersonal in medical appointments</i>			
At least weekly	16.1%	27.5%	33.9%
Several times a month or less	58.1%	53.6%	61.8%
Never	25.8%	18.9%	4.3%

*Meticulous data collectors* constitute the second largest group (35.8%). They stand out for arguably the most elaborate self-tracking routine in terms of registration. Their eponymous characteristic ‘meticulous’ refers to how likely they are to collect data regularly and how many different types of data they probably keep track of. The only exception is the amount of milk drunk during breastfeeding and pumping length. Although not to the same extent as the *advisory-oriented self-trackers*, this usage type is probable to retrieve several forms of algorithmic feedback. While they are presumably not overly focused on reward systems, personalised advice is at least moderately used. Concerning conversation, this group differs from the *straightforward basic trackers* only in that they are more likely to engage in interpersonal talks slightly more often.

*Advisory-oriented self-trackers* are the smallest group (21.2%), characterised by a relatively high uptake of all modes of self-tracking. Although their registrative activities do not seem as thorough as those of the meticulous data collectors, they are very likely to log numerous types of data, at least occasionally. Despite the low rates, this type is more likely to incorporate wearables for breastfeeding purposes. Furthermore, they appear to hold strong demands for all kinds of algorithmic feedback, including personalised advice and rewards. Their conversational

acts also reflect their engagement with ‘advisory’ aspects of self-tracking systems. Not only are they most likely to discuss their results in person, but unlike the other two groups, sharing tracked data within the app or on social media is more likely among this group.

### Further Comparison of Self-Tracking Usage Types

Based on the LCA presented above, we assigned participants to the class to which they most likely belong to further analyse and compare these usage types (see Tables 2 and 3).

The initial motivation to download a self-tracking app for breastfeeding most often originated from the users themselves (73.5%), with no significant differences between the three usage types. Referrals from third parties to install a breastfeeding tracker are significantly more prevalent among *advisory-oriented self-trackers*, both from their personal network (37.5%) and medical professionals (18.8%; see Table 4). Fitting in with their different use of feedback features, we also see significant differences between the three groups in using push messages and setting up personalised advice. While only one-third of *straightforward basic trackers* (33.6%) enable push notifications, half of *meticulous data collectors* (51.4%) and two-thirds of *advisory-oriented self-trackers* (68.8%) do so. Taking a look at how the usage types make use of personalised advice, it becomes clear that straightforward basic trackers and advisory-oriented self-trackers primarily rely on self-adjusted prompts and reminders (71.4%; 86.4%), whereas default app recommendations are less of an option (28.6%; 13.6%). This ratio is less evident for the meticulous data collectors, who, next to self-adjusting (52%), also draw on pre-set advice from the app (48%).

**Table 4.** Comparison of Self-Tracking Breastfeeding Types Regarding Further Usage Parameters

	Straightforward Basic Trackers	Meticulous Data	Advisory-Oriented Self-trackers	Total	$\chi^2$	$p$
<b>Reason to download</b>						
Autonomous search	73.5%	71.4%	77.1%	73.5%	0.50	.778
Recommendation	20.6%	19.0%	37.5%	23.5%	6.64	.036
personal network						
Recommendation	4.9%	8.3%	18.8%	9.0%	7.73	.021
medical professionals						
<b>Push messages</b>						
Yes	33.6%	51.4%	68.8%	48.2%	14.70	<.001
No	66.3%	48.6%	31.1%	51.8%		
<b>Settings for personalised advice</b>						
Only self-adjusted	71.4%	52.0%	86.4%	68.9%	6.50	.039
Additional default app advice	28.6%	48.0%	13.6%	31.1%		

Table 5. Types of Self-Tracking by Smartphone Self-Extension

Self-Expression	Straightforward Basic Trackers	Meticulous Data Collectors	Advisory-Oriented Self-Trackers	F-value	p	$\eta^2$
Functional	3.8	3.8	4.0	2.43	.091	.02
Identity	1.8 <sub>a</sub>	1.9 <sub>a</sub>	2.9 <sub>b</sub>	26.22	<.001	.19

Note. Means with different subscripts differ at the  $p = .05$  level by Tukey's HSD. Scale from 1 to 5, the higher the value, the higher the level of smartphone self-extension.

### Levels of Functional and Identity Smartphone Self-Extension

To answer *RQ2*, we compare the identified breastfeeding self-tracking types regarding their functional and identity smartphone self-extension (see Table 5). The three groups rank at a comparable, medium-high level concerning functional self-extension. Meanwhile – consistent with their greater affinity towards all modes and varieties of self-tracking – identity self-extension is significantly more pronounced among *advisory-oriented self-trackers*.

### Self-Tracking Usage and Maternal Well-Being

We will now turn to the users' maternal well-being, answering our third research question. Again, we will juxtapose levels of maternal confidence, stress, and self-worth with the identified types of breastfeeding self-tracking (see Table 6).

As part of maternal confidence, breastfeeding self-efficacy and motivation differ significantly depending on the type of self-tracking usage. Interestingly enough, self-efficacy ranks significantly higher among those who track the least (*straightforward basic trackers*) than those who track the most rigor (*meticulous data collectors*). Motivation for breastfeeding is significantly less apparent among meticulous data collectors and straightforward basic trackers than among advisory-oriented self-trackers. Nonetheless, outside of breastfeeding – and thus outside of what is tracked – mothers in our sample experience motherhood hardly any differently. By the same token, no considerable differences can be observed for maternal stress and maternal self-worth: All mothers feel a moderate stress level. Indices of self-worth, that is, self-esteem and body appreciation, show a medium-high level throughout the sample. In sum, maternal well-being remains largely unaffected by different styles of self-tracking usage.

### Sociodemographic and Maternal Characteristics of Self-Tracking Usage Types

To obtain a more thorough understanding of the three usage types, we explore mothers' sociodemographic and maternal background information, both of which might explain differences in how the different types employ breastfeeding trackers in their daily lives (see Tables 7 and 8).

Sociodemographically, the three usage types only differ in terms of their occupation while breastfeeding. *Advisory-oriented self-trackers* are more likely to hold full-time (29.2%) or part-time positions (27.1%) than *straightforward basic trackers* (10.8% full-time; 21.6% part-time) and *meticulous data collectors* (19.0% full-time; 17.9% part-time). Comparing the types in terms of their maternal characteristics reveals that *advisory-oriented self-trackers* have on average more than one child ( $M = 2.1$ ) and correspondingly more breastfeeding experience (70.8%) than *straightforward basic trackers* ( $M = 1.6$ ; 47.1%) and *meticulous data collectors* ( $M = 1.5$ ; 39.3%). Still, none of the usage types have significantly more or less prior experience with breastfeeding trackers from previous breastfeeding periods.

Around one-fifth of *meticulous data collectors* (20.2%) and *advisory-oriented self-trackers* (21.3%) had a premature delivery of their current breastfeeding child compared to significantly less *straightforward basic trackers* (4.0%). In addition, nearly half of the births among *meticulous data collectors* required a caesarean section (45.2%). This rate is considerably lower among *advisory-oriented self-trackers* (22.9%) and *straightforward basic trackers* (17.6%).

Table 6. Types of Self-Tracking by Maternal Well-Being

Maternal Well-Being	Straightforward Basic Trackers	Meticulous Data Collectors	Advisory-Oriented Self-Trackers	F-value	p	$\eta^2$
<b>Confidence</b>						
Breastfeeding self-efficacy <sup>1</sup>	4.2 <sub>a</sub>	3.7 <sub>b</sub>	4.0 <sub>ab</sub>	9.56	<.001	.08
Breastfeeding motivation <sup>1</sup>	3.5 <sub>a</sub>	3.3 <sub>a</sub>	3.9 <sub>b</sub>	10.81	<.001	.09
Maternal experience <sup>2</sup>	3.0	3.0	2.8	1.83	.163	.02
<b>Stress</b>						
Perceived Stress <sup>1</sup>	3.0	3.0	2.9	0.47	.624	.00
<b>Self-worth</b>						
Self-esteem <sup>1</sup>	3.9	3.8	3.7	2.19	.114	.02
Body appreciation <sup>1</sup>	3.4	3.4	3.5	0.40	.670	.00

Note. Means with different subscripts differ at the  $p = .05$  level by Tukey's HSD. <sup>1</sup>Scale 1 to 5, the higher the value, the higher the level of breastfeeding self-efficacy, breastfeeding motivation, perceived stress, self-esteem, and self-worth; <sup>2</sup>Scale 1 to 4, the higher the value, the more positive mothers experience maternity.

Table 7. Comparison of Self-Tracking Breastfeeding Types Regarding Age and Number of Children

Variables	Straightforward Basic Trackers	Meticulous Data Collectors	Advisory-Oriented Self-Trackers	F-value	p	$\eta^2$
Age	31.3	31.2	30.3	1.00	.371	.01
Number of children	1.6 <sub>a</sub>	1.5 <sub>a</sub>	2.1 <sub>b</sub>	8.95	<.001	.07

Note. Means with different subscripts differ at the  $p = .05$  level by Tukey's HSD.

**Table 8.** Comparison of Self-Tracking Breastfeeding Types Regarding Further Sociodemographic and Maternal Characteristics

Characteristics	Straightforward Basic Trackers	Meticulous Data Collectors	Advisory- Oriented Self-Trackers	Total	$\chi^2$	<i>p</i>
<b>Sociodemographic characteristics</b>						
<i>Educational level</i>						
With 'Abitur'	56.9%	46.4%	62.5%	54.3%	3.67	.160
Without 'Abitur'	43.1%	53.6%	37.5%	45.7%		
<i>Occupation (during breastfeeding period)</i>						
Full-time	10.8%	19.0%	29.2%	17.1%	10.54	.032
Part-time	21.6%	17.9%	27.1%	21.8%		
No	67.6%	63.1%	43.8%	61.1%		
<i>Partnership</i>						
Yes	98.0%	94.0%	95.8%	96.2%	2.00	.367
No	2.0%	6.0%	4.2%	3.8%		
<b>Maternal characteristics</b>						
<i>Previous breastfeeding experience</i>						
Yes	47.1%	39.3%	70.8%	49.1%	12.48	.002
No	52.9%	60.7%	29.2%	50.1%		
<i>Previous breastfeeding tracker use</i>						
Yes	37.2%	51.9%	66.7%	48.4%	5.09	.078
No	62.8%	48.1%	33.3%	51.6%		
<b>Details on the birth of the current breastfeeding child</b>						
<i>Premature delivery</i>						
Yes	4.0%	20.2%	21.3%	13.4%	13.69	.001
No	96.0%	79.8%	78.7%	86.6%		
<i>Caesarean delivery</i>						
Yes	17.6%	45.2%	22.9%	28.6%	18.13	<.001
No	82.4%	54.8%	77.1%	71.4%		

## Discussion

Following the proposed modes of engagement with self-tracking technology, we aimed to identify differences in how mothers use apps to monitor breastfeeding. Building on this typology and taking the dimension of smartphone self-extension into account, we set out to investigate how users' self-tracking usage ties in with their maternal well-being, particularly confidence, stress, and self-worth. Drawing on a survey with German mothers who use mobile breastfeeding trackers, we conducted a latent class analysis that factors in acts of registration,

algorithmic feedback, and conversation. This procedure allowed us to identify three types of self-tracking usage: *straightforward basic trackers*, *meticulous data collectors*, and *advisory-oriented self-trackers*.

*Straightforward basic trackers* show a laid-back approach to self-tracking. In terms of parameters tracked, they register the essentials, i.e., time and length of breastfeeding, but virtually nothing beyond that. Accordingly, as with the *meticulous data collectors*, usage of supplemental tracking devices is atypical. In line with that, their engagement with other modes of self-tracking can be described as somewhat restrained. While they use general advice and visualised statistics, more advanced features of algorithmic feedback like personalized advice, rewards, and push messages do not intrigue them as much. Compared to the two other usage types, *straightforward basic trackers* participate least in conversations about tracked data.

A far more extensive self-tracking program in terms of registration is evident among the *meticulous data collectors*. Mothers in this group rarely skip data entry: They keep track of the most parameters and do so in the most regular manner. Different kinds of algorithmic feedback seem to play a crucial role in how this usage type manages infant feeding, with general advice and visualisation being the most important. Furthermore, *meticulous data collectors* admittedly self-adjust personalised prompts, but contrary to the two other groups, they are more likely to rely on the app's default recommendations. Regarding conversation, they resemble straightforward basic trackers in that they shy away from online activities of data sharing. However, they are slightly more amenable to talk about tracked data face-to-face.

The modes with which the above-described groups engage only to a limited extent loom larger among the *advisory-oriented self-trackers*. Although not as broadly as the meticulous data collectors, this usage type still registers a significant share of parameters. These provide the basis for their advisory-oriented approach to self-tracking: they are most likely to retrieve all forms of algorithmic feedback, down to personalised advice and rewards. Moreover, they are more inclined to talk about their tracking experience across all channels. Their higher involvement in all modes of self-tracking is also reflected in that they at least partially connect the breastfeeding tracker with other devices.

Considering users' overall attachment to their smartphones, a pattern emerges that reflects the properties of the identified usage types. While there are no significant differences regarding functional self-extension, *advisory-oriented self-trackers* show significantly higher levels of identity smartphone self-extension compared to the other two usage types. Mirroring their almost ludic use of and high engagement with all three modes of self-tracking, this is a fitting result. These findings lead us to assume that users already firmly attached to their mobile devices might engage more with all offered features of self-tracking systems, while users showing a more distanced connection to their devices might stick to the basics.

While there are noticeable differences in how mothers engage with breastfeeding trackers, our results indicate no major disparities in how they feel mentally. Especially in terms of overall maternal experience, stress, and self-worth, all mothers reported relatively similar levels of well-being. When considering well-being solely regarding breastfeeding, varying levels of self-efficacy and motivation between the usage types become apparent. This finding is concerning insofar as it falls into the scope of what these mothers aim to manage through self-tracking. Notably, breastfeeding self-efficacy is significantly less pronounced among those who track the most rigorous (*meticulous data collectors*) compared to the straightforward basic trackers, who track least intensively. Therefore, a less data-driven nursing routine could imply that these

mothers already feel more comfortable breastfeeding. Perhaps using a breastfeeding app serves the very purpose of confirmation rather than guidance and improvement.

In contrast, more detailed self-tracking routines do not enhance mothers' perceptions of their ability to breastfeed. If anything, one could even argue that more elaborate tracking styles promote uncertainty as a side effect of the "constant visibility" (Sanders, 2017, p. 53) of one's maternal performance. Another explanation could be that mothers who extensively monitor breastfeeding already feel more doubtful and insecure about it, hence using self-tracking to obtain control. Indeed, this would also fit with the finding that significantly more women among the *meticulous data collectors* delivered their current breastfeeding child by caesarean section or prematurely, which also poses extra physiological challenges to infant feeding. However, on a more positive note, *advisory-oriented self-trackers* show the highest level of breastfeeding motivation. Arguably, this could stem from their feedback-focused and conversation-heavy usage style. In that sense, gamification elements, like rewards, or the exchange with others, keep them going. Maternal context information also indicates that mothers in this group have more breastfeeding (tracker) experience, possibly making them more versed and relaxed in this regard.

## Limitations and Conclusions

This study comes with certain limitations that inform future research. First, our sample only consisted of mothers engaging with breastfeeding trackers, neglecting mothers who do not make use of such applications. Hence, future research should aim to incorporate non-trackers' perspectives on the value of these apps. A more heterogeneous sample would also enable a more comprehensive assessment and comparison of maternal well-being. Besides, the cross-sectional design of our study did not allow evaluations of appropriation processes regarding breastfeeding trackers. Accordingly, future research on the use of self-tracking technologies could benefit from longitudinal studies to understand how users incorporate the system into their (breastfeeding) routine over time. This could conceivably involve a multimethod approach with a diary study in which mothers reflect on their mental state rather than just stating it off-the-cuff in the questionnaire. In addition, such a longitudinal approach could also give hints at causal mechanisms happening between self-tracking usage and maternal well-being. Finally, we must acknowledge the sampling via an online access as a limitation, as this procedure naturally harbours the risk of selection bias. In this respect, we should at least be aware of self-selection and noncoverage as constraints to the generalisability of our findings.

Still, the current study contributes to the literature on self-tracking technology and mothers' employment of mHealth applications. In particular, smartphone self-extension as a determinant on users' individual self-tracking experience proved to be a fertile theoretical consideration to enhance future studies on self-tracking. Beyond the mere identification of usage types, this study also provides important insights into the potentials and risks regarding mothers' perceptions in their breastfeeding abilities relative to the frequency and intensity of their self-tracking use. To provide effective app-supported smartphone interventions, we need to know more about the current app market for breastfeeding trackers. Thus, it is essential to learn how satisfied women are with the currently available apps, whether the systems and features offered meet their individual needs, and whether they think that smartphone interventions can help



them achieve and maintain a healthy relationship toward breastfeeding. These questions need to be explored in more depth in future studies.

## Notes

1. The full questionnaire can be found here:  
[https://osf.io/pgt3w/?view\\_only=4234229361464a75962556b391a40836](https://osf.io/pgt3w/?view_only=4234229361464a75962556b391a40836).
2. Low educational level in the German educational system refers to the attendance or completion of ‘Mittelschule’ with a Basic or Qualifying Secondary School Certificate. This degree equates to the Secondary School Certificate in the British educational system. Middle educational level refers to the completion of ‘Realschule’ with a Middle Maturity Certificate, corresponding to the General Certificate of Secondary Education (GCSE). Higher educational level refers to the obtainment of the matriculation standard ‘Abitur’, which is equivalent to A-Levels.
3. The R Markdown files for all analyses can be found here:  
[https://osf.io/pgt3w/?view\\_only=4234229361464a75962556b391a40836](https://osf.io/pgt3w/?view_only=4234229361464a75962556b391a40836).

## Funding

There has not been any funding for this project.

## Conflict of Interest

The authors do not declare any conflict of interest.

## Ethical Approval

According to the regulations of the authors’ institutions, obtaining ethical approval was not mandatory. Data were collected anonymously via an online survey. Participation was voluntary, and respondents gave written informed consent before taking part in the study.

## References

- Ahmed, A. H., Roumani, A. M., Szucs, K., Zhang, L., & King, D. (2016). The effect of interactive web-based monitoring on breastfeeding exclusivity, intensity, and duration in healthy, term infants after hospital discharge. *Journal of Obstetric, Gynecologic, and Neonatal Nursing: JOGNN*, 45(2), 143–154. <https://doi.org/10.1016/j.jogn.2015.12.001>
- Alves, E., Magano, R., Amorim, M., Nogueira, C., & Silva, S. (2016). Factors influencing parent reports of facilitators and barriers to human milk supply in neonatal intensive care units. *Journal of Human Lactation*, 32(4), 695–703. <https://doi.org/10.1177/0890334416664071>
- Amaratugna, D., Baldry, D., Sarshar, M., & Newton, R. (2002). Quantitative and qualitative research in the built environment: application of “mixed” research approach. *Work Study*, 51(1), 17–31. <https://doi.org/10.1108/00438020210415488>

- Awaliyah, S. N., Rachmawati, I. N., & Rahmah, H. (2019). Breastfeeding self-efficacy as a dominant factor affecting maternal breastfeeding satisfaction. *BMC Nursing*, *18*(S1), Article 30. <https://doi.org/10.1186/s12912-019-0359-6>
- Belk, R. W. (1988). Possessions and the extended self. *Journal of Consumer Research*, *15*(2), 139–168. <https://doi.org/10.1086/209154>
- Brettschneider, A.-K., Lippe, E. von der, & Lange, C. (2018). Stillverhalten in Deutschland – Neues aus KiGGS Welle 2 [Breastfeeding behavior in Germany – News from KiGGS Wave 2]. *Bundesgesundheitsblatt, Gesundheitsforschung, Gesundheitsschutz*, *61*(8), 920–925. <https://doi.org/10.1007/s00103-018-2770-7>
- Byrt, A. & Dempsey, D. (2020). Encouraging ‘good’ motherhood: Self-tracking and the provision of support on apps for parents of premature infants. *Information, Communication & Society*, *25*(8), 1135–1150. <https://doi.org/10.1080/1369118X.2020.1850837>
- Cannon, S., Lastella, M., Vincze, L., Vandelanotte, C., & Hayman, M. (2020). A review of pregnancy information on nutrition, physical activity and sleep websites. *Women and Birth: Journal of the Australian College of Midwives*, *33*(1), 35–40. <https://doi.org/10.1016/j.wombi.2018.12.007>
- Celeux, G. & Soromenho, G. (1996). An entropy criterion for assessing the number of clusters in a mixture model. *Journal of Classification*, *13*(2), 195–212. <https://doi.org/10.1007/BF01246098>
- Cohen, S., Kamarck, T., & Mermelstein, R. (1983). A global measure of perceived stress. *Journal of Health and Social Behavior*, *24*(4), 385–396. <https://doi.org/10.2307/2136404>
- Costa Figueiredo, M., Caldeira, C., Eikey, E. V., Mazmanian, M., & Chen, Y. (2018). Engaging with health data. *Proceedings of the ACM on Human-Computer Interaction*, *2*(CSCW), 1–20. <https://doi.org/10.1145/3274309>
- Declercq, E. R., Sakala, C., Corry, M. P., Applebaum, S., & Herrlich, A. (2013). *Listening to mothers III: pregnancy and birth*. Childbirth Connection. <https://www.nationalpartnership.org/our-work/resources/health-care/maternity/listening-to-mothers-iii-pregnancy-and-birth-2013.pdf>
- Demirci, J. R. & Bogen, D. L. (2017). Feasibility and acceptability of a mobile app in an ecological momentary assessment of early breastfeeding. *Maternal & Child Nutrition*, *13*(3), Article e12342. <https://doi.org/10.1111/mcn.12342>
- Dennis, C.-L. (2003). The breastfeeding self-efficacy scale: Psychometric assessment of the short form. *Journal of Obstetric, Gynecologic, and Neonatal Nursing*, *32*(6), 734–744. <https://doi.org/10.1177/0884217503258459>
- Dienelt, K., Moores, C. J., Miller, J., & Mehta, K. (2020). An investigation into the use of infant feeding tracker apps by breastfeeding mothers. *Health Informatics Journal*, *26*(3), 1672–1683. <https://doi.org/10.1177/1460458219888402>
- Flax, V. L., Negerie, M., Ibrahim, A. U., Leatherman, S., Daza, E. J., & Bentley, M. E. (2014). Integrating group counseling, cell phone messaging, and participant-generated songs and dramas into a microcredit program increases Nigerian women’s adherence to international breastfeeding recommendations. *The Journal of Nutrition*, *144*(7), 1120–1124. <https://doi.org/10.3945/jn.113.190124>
- Gibson, L. & Hanson, V. L. (2013). Digital motherhood. In W. E. Mackay, S. Brewster, & S. Bødker (Eds.), *Proceedings of the SIGCHI conference on human factors in computing systems* (pp. 313–322). ACM. <https://doi.org/10.1145/2470654.2470700>

- Griffin, L. B., López, J. D., Ranney, M. L., Macones, G. A., Cahill, A. G., & Lewkowitz, A. K. (2021). Effect of novel breastfeeding smartphone applications on breastfeeding rates. *Breastfeeding Medicine: The Official Journal of the Academy of Breastfeeding Medicine*, 16(8), 614–623. <https://doi.org/10.1089/bfm.2021.0012>
- Horta, B. L. & Victora, C. G. (2013a). *Short-term effects of breastfeeding. A systematic review on the benefits of breastfeeding on diarrhoea and pneumonia mortality*. World Health Organization. <https://apps.who.int/iris/handle/10665/95585>
- Horta, B. L. & Victora, C. G. (2013b). *Long-term effects of breastfeeding: A systematic review*. World Health Organization. <https://apps.who.int/iris/handle/10665/79198>
- Hermesen, S., Frost, J., Renes, R. J., & Kerkhof, P. (2016). Using feedback through digital technology to disrupt and change habitual behavior: A critical review of current literature. *Computers in Human Behavior*, 57, 61–74. <https://doi.org/10.1016/j.chb.2015.12.023>
- Hughson, J.-A. P., Daly, J. O., Woodward-Kron, R., Hajek, J., & Story, D. (2018). The rise of pregnancy apps and the implications for culturally and linguistically diverse women: Narrative review. *JMIR Mhealth and Uhealth*, 6(11), Article e189. <https://doi.org/10.2196/mhealth.9119>
- Hutchinson, J. & Cassidy, T. (2021). Well-being, self-esteem and body satisfaction in new mothers. *Journal of Reproductive and Infant Psychology*, 1–15. <https://doi.org/10.1080/02646838.2021.1916452>
- Hobbs, A. J., Mannion, C. A., McDonald, S. W., Brockway, M., & Tough, S. C. (2016). The impact of caesarean section on breastfeeding initiation, duration and difficulties in the first four months postpartum. *BMC Pregnancy and Childbirth*, 16(1), 90. <https://doi.org/10.1186/s12884-016-0876-1>
- Jaks, R., Baumann, I., Juvalta, S., & Dratva, J. (2019). Parental digital health information seeking behavior in Switzerland: A cross-sectional study. *BMC Public Health*, 19(1), 225. <https://doi.org/10.1186/s12889-019-6524-8>
- Jayaseelan R., Pichandy C., & Rushandramani D (2015). Usage of smartphone apps by women on their maternal life. *Research Journal of Science and Technology*, 7(3), 158–164. <http://dx.doi.org/10.5958/2349-2988.2015.00022.4>
- Johnson, S. (2014). “Maternal devices”, social media and the self-management of pregnancy, mothering and child health. *Societies*, 4(2), 330–350. <https://doi.org/10.3390/soc4020330>
- Karnowski, V. & Reifegerste, D. (2021, May 27-31). *Untangling the heterogeneity: an empirical investigation into German young adults’ engagement with self-tracking of physical activity* [Paper presentation]. Seventy-first annual conference of the International Communication Association, virtual conference.
- Kestler-Peleg, M., Shamir-Dardikman, M., Hermoni, D., & Ginzburg, K. (2015). Breastfeeding motivation and self-determination theory. *Social Science & Medicine*, 144, 19–27. <https://doi.org/10.1016/j.socscimed.2015.09.006>
- Knittel, M., Kollig, F., Mason, A., & Wash, R. (2021). Anyone else have this experience. *Proceedings of the ACM on Human-Computer Interaction*, 5(CSCW1), 1–30. <https://doi.org/10.1145/3449153>
- Kraschnewski, J. L., Chuang, C. H., Poole, E. S., Peyton, T., Blubaugh, I., Pauli, J., Feher, A., & Reddy, M. (2014). Paging “Dr. Google”: Does technology fill the gap created by the prenatal care visit structure? Qualitative focus group study with pregnant women. *Journal of Medical Internet Research*, 16(6), Article e147. <https://doi.org/10.2196/jmir.3385>

- Lagan, B. M., Sinclair, M., & Kernohan, W. G. (2010). Internet use in pregnancy informs women's decision making: A web-based survey. *Birth, 37*(2), 106–115. <https://doi.org/10.1111/j.1523-536X.2010.00390.x>
- Leiner, D. J. (2019). Too fast, too straight, too weird: Non-reactive indicators for meaningless data in internet surveys. *Survey Research Methods, 13*(3), 229–248. <https://doi.org/10.18148/srm/2019.v13i3.7403>
- Lewkowitz, A. K., López, J. D., Werner, E. F., Ranney, M. L., Macones, G. A., Rouse, D. J., Savitz, D. A., & Cahill, A. G. (2021). Effect of a novel smartphone application on breastfeeding rates among low-income, first-time mothers intending to exclusively breastfeed: Secondary analysis of a randomized controlled trial. *Breastfeeding Medicine, 16*(1), 59–67. <https://doi.org/10.1089/bfm.2020.0240>
- Linzer, D. A. & Lewis, J. B. (2011). poLCA: An R package for polytomous variable latent class analysis. *Journal of Statistical Software, 42*(10). <https://doi.org/10.18637/jss.v042.i10>
- Litterbach, E.-K., Russell, C. G., Taki, S., Denney-Wilson, E., Campbell, K. J., & Laws, R. A. (2017). Factors influencing engagement and behavioral determinants of infant feeding in an mHealth program: Qualitative evaluation of the growing healthy program. *JMIR MHealth and UHealth, 5*(12), Article e196. <https://doi.org/10.2196/mhealth.8515>
- Lomborg, S., Thylstrup, N. B., & Schwartz, J. (2018). The temporal flows of self-tracking: Checking in, moving on, staying hooked. *New Media & Society, 20*(12), 4590–4607. <https://doi.org/10.1177/1461444818778542>
- Lupton, D. (2017). 'It just gives me a bit of peace of mind': Australian women's use of digital media for pregnancy and early motherhood. *Societies, 7*(3), Article 25. <https://doi.org/10.3390/soc7030025>
- Lupton, D. (2014, August 27). Self-tracking modes: Reflexive self-monitoring and data practices [paper presented]. Imminent citizenships: Personhood and identity politics in the informatic age workshop, Canberra, Australia. <https://dx.doi.org/10.2139/ssrn.2483549>
- Lupton, D. & Pedersen, S. (2016). An Australian survey of women's use of pregnancy and parenting apps. *Women and Birth: Journal of the Australian College of Midwives, 29*(4), 368–375. <https://doi.org/10.1016/j.wombi.2016.01.008>
- Lupton, D., Pedersen, S., & Thomas, G. M. (2016). Parenting and digital media: From the early web to contemporary digital society. *Sociology Compass, 10*(8), 730–743. <https://doi.org/10.1111/soc4.12398>
- Lupton, D. & Thomas, G. M. (2015). Playing pregnancy: The ludification and gamification of expectant motherhood in smartphone apps. *M/C Journal, 18*(5). <https://doi.org/10.5204/mcj.1012>
- Matthey, S. (2011). Assessing the experience of motherhood: The being a mother scale (BaM-13). *Journal of Affective Disorders, 128*(1-2), 142–152. <https://doi.org/10.1016/j.jad.2010.06.032>
- Mulisa, F. (2021). When does a researcher choose a quantitative, qualitative, or mixed research approach? *Interchange, 53*, 113 – 131. <https://doi.org/10.1007/s10780-021-09447-z>
- O'Higgins, A., Murphy, O. C., Egan, A., Mullaney, L., Sheehan, S., Turner, M. (2014). The use of digital media by women using the maternity services in a developed country. *Irish Medical Journal, 107*(10), 313–315.

- Park, C. S. & Kaye, B. K. (2019). Smartphone and self-extension: Functionally, anthropomorphically, and ontologically extending self via the smartphone. *Mobile Media & Communication*, 7(2), 215–231. <https://doi.org/10.1177/2050157918808327>
- Plantin, L. & Daneback, K. (2009). Parenthood, information and support on the internet. A literature review of research on parents and professionals online. *BMC Family Practice*, 10, Article 34. <https://doi.org/10.1186/1471-2296-10-34>
- Quintiliano-Scarpelli, D., Lehmann, N., Castillo, B., & Blanco, E. (2021). Infant feeding and information sources in Chilean families who reported baby-led weaning as a complementary feeding method. *Nutrients*, 13(8), Article 2707. <https://doi.org/10.3390/nu13082707>
- Roll, C. L. & Cheater, F. (2016). Expectant parents' views of factors influencing infant feeding decisions in the antenatal period: A systematic review. *International Journal of Nursing Studies*, 60, 145–155. <https://doi.org/10.1016/j.ijnurstu.2016.04.011>
- Rosenbaum, D. L., Gillen, M. M., & Markey, C. H. (2020). Feeling let down: An investigation of breastfeeding expectations, appreciation of body functionality, self-compassion, and depression symptoms. *Appetite*, 154, Article e104756. <https://doi.org/10.1016/j.appet.2020.104756>
- Rosenberg, M. (1965). *Society and the adolescent selfimage*. Princeton University Press.
- Ross, M. Q. & Bayer, J. B. (2021). Explicating self-phones: Dimensions and correlates of smartphone self-extension. *Mobile Media & Communication*, 9(3), 488–512. <https://doi.org/10.1177/2050157920980508>
- Ross, M. Q. & Campbell, S. W. (2021). Thinking and feeling through mobile media and communication: A review of cognitive and affective implications. *Review of Communication Research*, 9, 147-166.
- Sanders, R. (2017). Self-tracking in the digital era. *Body & Society*, 23(1), 36–63. <https://doi.org/10.1177/1357034X16660366>
- Schneider, E. E., Schönfelder, S., Domke-Wolf, M., & Wessa, M. (2020). Measuring stress in clinical and nonclinical subjects using a German adaptation of the perceived stress scale. *International Journal of Clinical and Health Psychology*, 20(2), 173–181. <https://doi.org/10.1016/j.ijchp.2020.03.004>
- Schwarz, E. B. & Nothnagle, M. (2015). The maternal health benefits of breastfeeding. *American Family Physician*, 91(9), 602–604.
- Sharon, T. (2017). Self-tracking for health and the quantified self: Re-articulating autonomy, solidarity, and authenticity in an age of personalized healthcare. *Philosophy & Technology*, 30(1), 93–121. <https://doi.org/10.1007/s13347-016-0215-5>
- Silva, A. B., Assumpção, A. M. B. de, Andrade Filha, I. G. de, Regadas, C. T., Castro, M. C. de, Silva, C. R. A., Assumpção, M. R., Santos, R. C. B. dos, Silvério, T. O., Santos, P. B. dos, Silva, D. A. da, Paulino, B. V., & Pastorelli, P. P. L. (2019). Cross-cultural adaptation of the Zero Mothers Die (ZMD App) in Brazil: Contributing to digital health with the approach on care centred for e-pregnant woman. *Revista Brasileira de Saúde Materno Infantil*, 19(4), 751–762. <https://doi.org/10.1590/1806-93042019000400002>
- Thomas, G. M. & Lupton, D. (2016). Threats and thrills: Pregnancy apps, risk and consumption. *Health, Risk & Society*, 17(7-8), 495–509. <https://doi.org/10.1080/13698575.2015.1127333>
- Thornham, H. (2019). Algorithmic vulnerabilities and the datalogical: Early motherhood and tracking-as-care regimes. *Convergence*, 25(2), 171–185. <https://doi.org/10.1177/1354856519835772>



- Thylstrup, N. B. & Lomborg, S. (2017, August 17-19). *Self-tracking and flow* [Paper presentation]. Twenty-third Nordic Conference on Media and Communication Research, Tampere, Finland.
- Trafford, Z., Jewett, S., Swartz, A., LeFevre, A. E., Winch, P. J., Colvin, C. J., Barron, P., & Bamford, L. (2020). Reported infant feeding practices and contextual influences on breastfeeding: qualitative interviews with women registered to MomConnect in three South African provinces. *International Breastfeeding Journal*, *15*(1), Article 81. <https://doi.org/10.1186/s13006-020-00315-7>
- Tylka, T. L. & Wood-Barcalow, N. L. (2015). The body appreciation scale-2: Item refinement and psychometric evaluation. *Body Image*, *12*, 53–67. <https://doi.org/10.1016/j.bodyim.2014.09.006>
- van Dijck, J. (2014). Datafication, dataism and dataveillance: Big data between scientific paradigm and ideology. *Surveillance & Society*, *12*(2), 197–208. <https://doi.org/10.24908/ss.v12i2.4776>
- Virani, A., Duffett-Leger, L., & Letourneau, N. (2019). Parenting apps review: In search of good quality apps. *mHealth*, *5*, Article 44. <https://doi.org/10.21037/mhealth.2019.08.10>
- Von Collani, G. & Herberg, P. Y. (2003). Zur internen Struktur des globalen Selbstwertgefühls nach Rosenberg [On the internal structure of global self-esteem according to Rosenberg]. *Zeitschrift für Differentielle und Diagnostische Psychologie*, *24* (1), 9–22.
- Wang, C.-J., Chaovalit, P., & Pongnumkul, S. (2018). A breastfeed-promoting mobile app intervention: Usability and usefulness study. *JMIR MHealth and UHealth*, *6*(1), Article e27. <https://doi.org/10.2196/mhealth.8337>
- Wheaton, N., Lenehan, J., & Amir, L. H. (2018). Evaluation of a breastfeeding app in rural Australia: Prospective cohort study. *Journal of Human Lactation*, *34*(4), 711–720. <https://doi.org/10.1177/0890334418794181>
- World Health Organization [WHO]. *Guideline: Protecting, promoting and supporting breastfeeding in facilities providing maternity and newborn services*. <http://apps.who.int/iris/bitstream/handle/10665/259386/9789241550086-eng.pdf>

## Author Contributions

Conceptualisation (main idea, theory): Nariman Sawalha & Veronika Karnowski

Funding acquisition: not applicable

Project administration: Nariman Sawalha & Veronika Karnowski

Methodology (design, operationalization): Nariman Sawalha & Veronika Karnowski

Data collection: Nariman Sawalha & Veronika Karnowski

Data analysis: Nariman Sawalha & Veronika Karnowski

Writing – original draft: Nariman Sawalha & Veronika Karnowski

Writing – review & editing: Nariman Sawalha & Veronika Karnowski

## Author Biographies

**Nariman Sawalha** is a research assistant at the Department of Communication Studies and Media Research, LMU Munich. Her research interests lie in the field of mobile communication and health communication, as well as their interconnection, mHealth.

**Veronika Karnowski** currently is a visiting professor at the Seminar of Media and Communications Studies, University of Erfurt. Her research focuses on mobile media, social media and news, as well as eHealth and mHealth.