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KAKŠNE VRSTE PERSONALIZACIJE SE UPORABLJAJO V APLIKACIJAH ZA NOSEČNOST: PREGLED LITERATURE

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Povzetek Digitalne aplikacije so kot sodobna, masovno uporabljana orodja, popularni vir informacij tudi za nosečnice. Pri tem je personalizacija ključna prodajna kategorija za to vrst aplikacij. Aplikacije za nosečnost so najbolj priljubljena vrsta digitalnih aplikacij za zdravje (n = 2900). Podroben opis raznolikosti in načina uporabe personaliziranih digitalnih orodij v široko uporabljanih aplikacijah za nosečnost. Pregled obsega je bil izveden z uporabo baz podatkov OvidSP z uporabo MEDLINE, EMBASE, PsychINFO za identifikacijo ustreznih člankov do avgusta 2017. Vključenih je bilo šest študij. Po definiciji personalizacije Blom (2000) so bile opisane vse bistvene dimenzije personalizacije. Personalizacija v digitalnih aplikacijah za nosečnost je v veliki meri odvisna od namena aplikacije za nosečnost. V literaturi ni aplikacije za nosečnost, ki bi vključevala vse razsežnosti in vidike personalizacije, opisane v tem pregledu. Prihodnje raziskave bi se morale osredotočiti na prilagajanje aplikacij, da bi dosegle uporabo pri ženskah iz različnih geografskih, socialnih, in kulturnih okolij.

Ključne besede:
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WHAT TYPES OF PERSONALISATION ARE USED IN PREGNANCY APPS: A SCOPING REVIEW

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Abstract Digital support is a preferred source of information for pregnant women with personalisation being a key selling benefit for pregnancy apps. Pregnancy apps are the most popular type of health app (n= 2,900). To describe the variety and use of personalisation in pregnancy apps. A scoping review was performed using OvidSP databases using MEDLINE, EMBASE, PsychINFO to identify relevant articles up until August 2017. 1,121 articles were identified after excluding duplicates. Six studies met inclusion criteria (one interview study, one online survey, two app reviews; two studies using critical discourse analysis). Different dimensions of personalisation were described based on Blom's (2000) definition of personalisation. Personalisation in pregnancy apps is largely determined by the functionality of the app (type of pregnancy app). There are no pregnancy apps that use all of the dimensions of personalisation described in this review. Future research should focus on personalising apps to reach underrepresented populations.

Keywords:
women's health, pregnancy, smartphone, review, mHealth

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1 Introduction

Pregnancy Smartphone Apps

Smartphone use is projected to increase from 2.1 billion subscriptions in 2015 to 6.1 billion in 2020, covering 70% of the world's population [1]. Recent studies showed that daily smartphone use is higher for women, along with a significantly higher degree of dependence and smartphone influence compared to men [2, 3, 4].
A 2015 review of 165,169 health-related apps on Apple App Store (Apple Inc.) and Google Play Store (Google LLC) stores reported that 7% (n=2,900) were women's health and pregnancy-related apps [5]. Most of these apps are free but lack privacy and content control [5, 6, 7]. The use of technology is common among perinatal women [8, 9] and can have significant positive effects (e.g., improved dietary choices) [10]. A recent narrative review of 38 studies found that pregnancy apps are principally used to access pregnancy health and foetal development information [11].

Standard UK care model for pregnancy

In the UK, women receive up to 45 paper-based patient information leaflets from healthcare professionals about pregnancy, birth, and postnatal care throughout a 'normal' pregnancy [12]. The gold standard of normal antenatal care is a continuity model, with care provided by the same one or two midwives [13]. It is well established that this model leads to both improved health outcomes and increased satisfaction in women. In this case, the midwife-woman relationship, developed through personalised care and information-sharing, contributes to increased feelings of trust and empowerment [14]. However, continuity is rarely achieved in practice and where standard antenatal care such as leaflets and face-to-face meetings do not meet women's well-being needs, women turn to other sources of information [15]. An app provIding consistent information and a level of personalisation may therefore act as a substitute for a trusting midwife-woman relationship.

Apps for the continuity of pregnancy care

Having a consistent, reliable app could potentially overturn the negative or burdensome experiences. A survey of UK women (N=50) found that pregnant women preferred accessing pregnancy-related information online compared to

leaflets and 86% (43/50) used a pregnancy-related smartphone app [13]. An Irish study found that women used a variety of digital sources, with 95% (498/522) using the internet for pregnancy information and 59% (235/399) using a pregnancy app [16].

Furthermore, National Maternity Review (2016, p. 34) found that women and their families wanted information to be evidence-based and available to them in a range of formats, including online [15]. They wanted information to be accessible when they needed it. For example, perinatal mental health problems affect between 10%-20% of women during pregnancy and the first year after having a baby, and strategies such as promoting healthy lifestyles, early identification and timely provision of quality specialised care are some of the actions that can reduce both incidence and severity of related child development issues. Parents' ability to bond with and care for the baby, their approaches to parenting, and fostering of a positive relationship can predict many physical, social, cognitive and emotional outcomes throughout adulthood (Clinical guideline [CG192]) [17, 18]. It is not clear if any pregnancy apps incorporate any of the mental health guidance for clinical management of antenatal and postnatal mental health, but personalised messaging could help women have better information when they need it.

Pregnancy app types

Several reviews have grouped pregnancy apps into various categories such as: i) *entertainment, ii) pregnancy iii) foetal monitoring* and iv) *pregnancy information apps* [19]. Additionally, they used two spectrums: 1) the information and functions of the apps were portraying pregnancy as a highly risky state or *a 'threat'*; 2) the information was entertaining and catering to the fun or '*thrilling'* aspects of expectant mothers [19]. Yet other researchers have split them into four categories: i) *informative, ii) interactive, iii) tools* and *iv) social media* apps [8]. Popularity, which the users rated, saw the highest preference for information apps and those with interactive features.

Pregnancy (tracker) apps which are the most common type of app allow women to set a variety of personal features varying from several babies carried, gender and name of the foetus, pre-existing conditions (e.g., diabetes), lifestyle choice (e.g., natural birth), weight. The content here is typically generic – corresponding to precise trimesters of pregnancy; but can also be more specific or tailored – based on

a woman's personal need or health status (e.g., if a woman has a specific health condition) [19].

Personalisation

A body of research has focused on studying personalisation. Personalisation can be defined as *"tailoring a service to a user's needs"* or *"appropriate responsiveness",* which is understanding strategies for doing the right thing at the right time [20, 21, 22]. Blom's (2000) broad definition of pertaining to apps states that personalisation is: *"a process that changes the functionality, interface, information, access, and content, or distinctiveness of a system to increase personal relevance to an individual or a category of individuals with the effect of the changes persisting across these sessions."* [23]. We decided to employ this definition of personalisation.

Personalisation is often used interchangeably with customisation, but customisation in some fields of research is distinctly a sub-set of personalisation, a much wider application of personalising care or service [24]. To take this into account, we included articles that talked about personalisation in terms of both 'customisation' and 'tailoring'.

Pregnancy is characterised by notable changes as it progresses from the first, second, and third trimesters. Having information about what is 'normal' and what is healthy at each stage is useful and reassuring, even more so if it is specifically tailored to each woman's health status or personal needs.

The vast majority of pregnant women are "savvy consumers" of online information; they expect digital tools to help empower them in their decision-making, but when there is so much information to choose from, women then resort to going back to the maternity care providers [13, 15]. This on the one hand fosters the relationship with the healthcare providers, but on the other hand, it poses a burden on the services [16]. The National Maternity Review (2016) calls for the development of a digital tool that would combat the demand posed on the services: "*Such a digital tool will have much greater value if it enables the personalisation of information. To that end, it must provide an interface with the woman's electronic maternity record, so that she can access her own record and receive information that is tailored to her needs.*" [15; pp. 52 – 53]

Because pregnancy is so common and digital apps so widespread, becoming entrenched in our healthcare, it is important to understand what is already known about the process of "doing the right thing at the right time" or simply personalisation in this set of apps. Personalisation can increase the awareness of health problems, potentially reducing costs to health services and deliver more streamlined health information to pregnant women based on their immediate needs. This scoping review also aims to describe a gap in knowledge-service provision for policymakers and healthcare developers to take into account when developing new digital tools for perinatal and antenatal health.

2 Method

PICo was instead of PICO because our research question concerned a specific context (Co) and did not include comparison with another type of app or population. Main outcomes were description of personalisation approaches, user preferences and the function of personalisation in pregnancy apps. Scoping reviews are not accepted in the International prospective register of systematic reviews – PROSPERO, thus this review has not been registered in the database.

Table 1: A detailed PICo table[a]

Sourec

Review question	**How is personalisation used in pregnancy apps?**
P	Women using mobile phone apps for pregnancy during gestation period
I	Personalisation, also expressed as customisation or tailoring in pregnancy apps. Women's experiences, views or researcher's analysis of pregnancy apps in qualitative, quantitative studies, other studies (e.g. narrative, discourse)
Co	Studies using app store descriptions or reviews of pregnancy apps, interviews with perinatal women speaking about their experiences with using pregnancy apps and specifically personalisation features, studies developing or testing personalisation approaches in pregnancy apps

[a] Instead of a PICO table this is a PICo table: population (P), phenomena of interest (I) and context (Co) (Joanna Briggs Institute, 2011) [b] Tailoring approaches and customisation are a sub-set of personalisation

2.1 Inclusion criteria

Studies were included in which the primary focus was to explore personalisation, also described as tailoring or customisation. Eligible studies must have examined any

type of pregnancy apps: either where the development or individual components of pregnancy apps were discussed (where these included personalisation, tailoring and customisation); reviews of pregnancy apps or studies where there was an explicit mention of personalisation; tailoring or customisation in pregnancy apps; and surveys with women using pregnancy apps. Studies had to be published in a peer-reviewed journal in the past 10 years (as apps were not widely available before circa 2008). All study designs were permitted.

2.2 Exclusion criteria

Studies were ineligible if: 1) they did not mention personalisation, tailoring or customisation; 2) they did not include a pregnancy app (e.g., such as web-based pregnancy information repositories or web-based programs); 3) they looked at apps that are primarily used outside pregnancy (e.g., fertility or period trackers); 4) they were published in a language other than English.

2.3 Search methods

Electronic databases MEDLINE, OVID (1946 to August 2017), EMBASE, (1974 to August 2017) PsychINFO, (1806 to August 2017 Week 2) were systematically searched to identify relevant articles. Broad key terms were deliberately chosen to make the search as sensitive as possible. The following search terms were applied:
1. Exp Pregnancy/
2. Pregnan*.tw1
3. Exp Telemedicine/
4. (smartphone OR app OR apps).tw
5. (mhealth OR m-health).tw

In addition, hand-searching of the reference lists (of all included papers) was performed. In total, three additional articles were added through this method. Although this was a scoping review because of the limited information on this topic, it was still important to search systematically for researchers to have a clear methodology which they can replicate.

2.4 Selection of Studies

Identified articles were screened for eligibility by NF. Any disagreements were discussed between NF and JF (an assistant student) to reach a consensus. The present scoping review was conducted and reported according to PRISMA (Preferred Reporting Items for Systematic reviews and Meta-Analyses) guidance (see Figure 1) [25].

2.5 Quality rating

There were several reasons quality appraisal was not conducted on studies included in this review. Firstly, this review aimed to describe personalisation in pregnancy apps, rather than evaluate the strength of personalisation. Secondly, due to the varying study designs, it was not possible to evaluate the quality of the studies included in the review as will be discussed in the results section. Thirdly, the quality of evidence does not necessarily imply strong recommendation of it, so quality assessment of the included studies is less relevant.

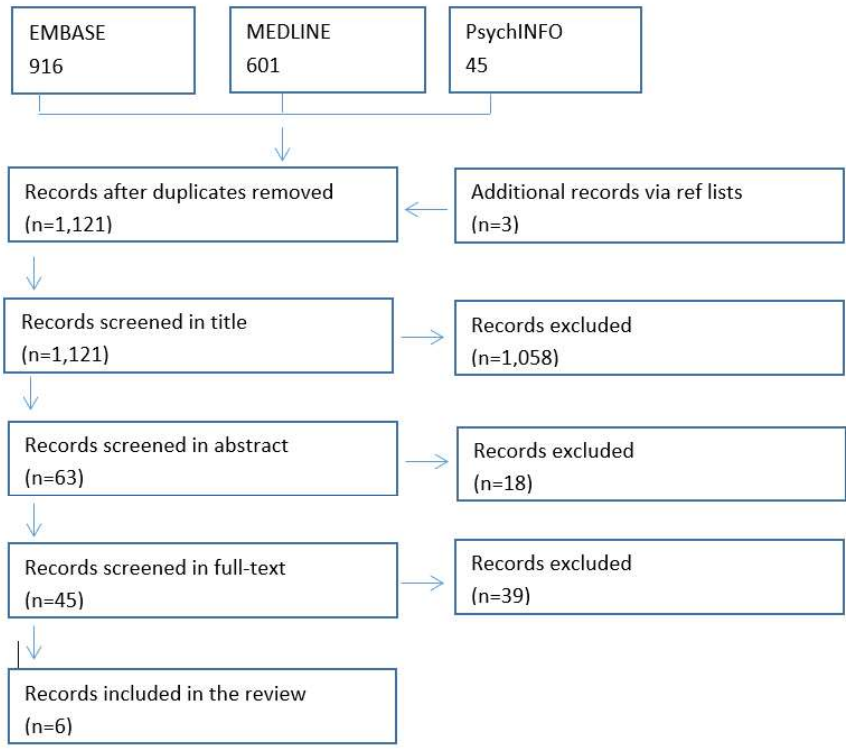

Figure 1: PRISMA selection process.
Source: own

2.6 Data synthesis

A standardised form for data extraction was applied. Data items in the extraction form included the following: author's name; country; publication year; study design; setting; sample size; type of the study and information regarding personalisation that appeared in the study. Data was synthesised using a meta-thematic approach [26] whereby we first included a description of personalisation as defined in these studies (Table 2) and then broke down different types of personalisation types using a thematic analysis, bringing together and integrating findings of multiple quantitative and qualitative studies.

3 Results

1,121 articles were identified from the database search after excluding duplicates (Figure 1). Six articles were included in the review after meeting the inclusion criteria.

3.1 Eligible Studies

All eligible studies were published between 2014 and 2016 and all were conducted in Australia except Lupton and Pedersen (2016) which also included women based in the UK. Methodological approaches varied and included one interview study, one online survey, two app reviews, and two studies using critical discourse analysis [8, 19, 27-30]. Three of the six papers (totalling 6,974 apps; n=4,482 pregnancy apps in iTunes store and 2,492 apps in Google Play store) were included analysis on the same set of apps. It was not possible to include an exact number as we could not be sure that the same sets of apps were analysed. The studies either interviewed pregnant women (mean number of participants = 303) or they studied apps (mean number of apps = 1,744).

The majority of excluded studies did not study or mention personalisation in pregnancy apps. Others considered personalisation in another set of apps such as fertility monitoring or period apps which were not relevant for our review and some

studies mentioned personalisation in mHealth apps in general or only in passing without direct relevance to pregnancy apps.

Table 2: Included studies

	Authors	Study design	Setting	Sample size and characteristics	Information regarding personalisation
1	Hearn, L., Miller, M., Lester, L. [27] Australia 2014	Focus groups and interview study	Interviews with 53 pregnant women attending hospital antenatal clinics in Western Australia (WA). 12 focus groups with a total of 67 postnatal mothers attending WA urban and rural playgroups	n=53 pregnant women (interviews) n=67 postnatal women (focus groups) n=76 perinatal healthcare providers (PHCPs) (interviews)	The outcome was the development of the clinically-endorsed Healthy You, Healthy Baby (HYHB) website and smartphone app, an interactive online resource that provides perinatal women with a personalised tool to track their weight, diet, physical activity, emotional wellbeing, and sleep patterns based on the developmental stage of their child with links to quality-assured information; Mothers highlighted that, they wanted hands-on "parent-focused" rather than "child-focused" interactive materials including personalised learning activities that would assist them to become role-models for healthier family lifestyles (behaviour to prevent obesity); Content criteria specified inclusion of online information related to healthy maternal lifestyle (nutrition, activity, and weight), healthy parental lifestyle and modelling to children, emotional wellbeing, and parenting advice, as well as quantity and quality of information; Format criteria included local connectedness
2	Tripp, N., Hainey, K., Liu,A. [8] Australia 2014	App review	The two smartphone platforms, Apple iOS and Android systems, were searched for pregnancy related apps and reviewed for their	n=497 pregnancy apps in Google Play store and n=1,059 apps in iTunes store	Reliance on healthcare professionals may be reduced by the availability of interactive and personalised information delivered via a smartphone; The traditional model of"shared maternity car" needs to accommodate electronic devices into its functioning; Interactive apps allow data input and offer appropriate gestation-specific information; Women are

			purpose and popularity		able to personalise an app to their specific needs, thereby strengthening the "relationship" women have with the app
3	Lupton, D., Thomas, G.M. [28] Australia 2015	Critical discourse analysis	Analysis of all pregnancy-related smartphone apps in the two major app stores (iTunes and Google Play), in late June 2015. Critical discourse analysis of the apps, looking closely at the app descriptions offered in the two stores	n=665 pregnancy apps in Google Play store and 1,141 apps in iTunes store	The 'Hi Mommy' app features a cartoon-like pink and cuddly foetus looking very baby-like addressing its mother from the womb; Several pregnancy-tracking apps also allow women to input the name that they have chosen for their expected baby, to receive customised notifications of its progress ('Justin is nine weeks and two days old today')
4	Thomas, G.M., Lupton, D. [19] Australia 2016	Critical discourse analysis	Analysis of all pregnancy-related smartphone apps in the two major app stores (iTunes and Google Play), in late June 2015. Critical discourse analysis of the apps, looking closely at the app descriptions offered in the two stores	Same as (3)	Apps allowing tracking of baby's development and pregnancy week by week'; Foetus themselves were often personalised in these apps studied; It is notable that many apps use the term baby rather than foetus; In conjunction with more 'serious' features such as a maternal weight tracker and following foetal growth via 'an informative video for each month of pregnancy', the app offered other features for women to 'track your memories and milestones in the app diary and personalise them with photos and 'our mood metre' to share across social media; Other features of the app included a hospital appointment planner ('record your doctor's answers to your questions'), to-do list templates, a hospital bag checklist for delivery, a list of obstetrician-recommended 'newborn essentials', a personalised timeline which 'adjusts to your baby's milestones and both a weight and a contraction tracker

5	Lupton, D. [29] Australia 2016	App review	Analysis of all pregnancy-related smartphone apps in the two major app stores (iTunes and Google Play), in late June 2015. Critical discourse analysis of the apps, looking closely at the app descriptions offered in the two stores	Same as (3)	In addition to features such as retrieving information, monitoring foetal or child development, participants talked about the value they placed on the customised and personalised nature of information they received from apps and online media; The use of apps to monitor feeding and sleeping patterns of infants was popular, as they provided detailed information about individual babies' habits; First-time mothers particularly appreciated these types of apps
6	Lupton, D., Pedersen, S. [30] Australia and UK 2016	Online survey	An online survey was completed by 410 women who were pregnant or had given birth to at least one child in the past three years, were aged between 18 and 45 and were competent in English.	n=410 women aged 18-45 years who were pregnant or given birth to one or more children in the past three years and have used a pregnancy-app	This study found that women wanted apps linked to trustworthy websites containing short answers to everyday concerns and personalised tools to assess their weight, nutrition and fitness

Source: own

3.2 Personalisation Approaches Used in Pregnancy Apps

We distilled the elements of personalisation in Table 3 according to Blom's (2000) broad definition of personalisation pertaining to apps: *"a process that changes the functionality, interface, information, access and content, or distinctiveness of a system to increase personal relevance to an individual or a category of individuals with the effect of the changes persisting across these sessions."* We used each of these dimensions (e.g., functionality, interface, information, etc. to show which aspects of personalisation play into each of these dimensions) [23].

3.3 Tracking and data

In the **pregnancy as a *'risk'* or *'threat'* group**, personalisation meant self-monitoring and close surveillance functions (such as inputting and tracking data) to tracking baby's development day-by-day and week-by-week. Lupton and Thomas (2015) further reported that based on woman's personal information, some apps offered a personalised timeline, suggestions for doctor's visits, personalised individual and baby's development milestones and an option to receive personalised alerts for health risks (e.g., fluid intake, exercise, food avoidance) [28]. A high proportion of women used pregnancy apps to receive information about foetal development (86%), followed by information about changes of the body during pregnancy (71%) [30]. Customisation of information in terms of monitoring and tracking babies feeding and sleeping patterns was also valued by women in other studies, especially because the apps provided detailed information for each infant individually such as in the Lupton and Pedersen (2016) study [30].

3.4 Entertainment and socialisation

In the **pregnancy as a *'thrills'* group**, personalisation offered users slightly different functions: entertaining features, including games, quizzes, pranks or products which helped make pregnancy an exciting and humorous time. Personalisation here included editing pregnancy images and sharing it on social media, baby gender and name predictors, or creating pregnancy messages. One app allowed women to track their pregnancy memories and later personalise them with various features, including a mood metre or videos. Although Lupton and Pedersen (2016) reported that less frequent reasons for use were uploading and storing photographs such as foetal ultrasound images or pregnancy images, Lupton (2015) reported that women ask for pregnancy apps that are customised, immediate, regular, detailed, entertaining, practical, professional and reassuring, which is a combination of *'threats'* and *'thrills'* [29, 30].

3.5 Tailored supportive feedback

Based on recommendations of key stakeholders, the *Healthy You, Healthy Baby (HYHB)* app contained a self-assessment tool to track maternal lifestyle behaviours and weight during pregnancy and the first 18 months of motherhood. Web information and app were integrated into a website of one of the leading West

Australian early childhood parent support organisations 'Ngala' [27]. The researchers designed a self-assessment tool within an app that generated supportive tailored feedback and tips on how to make improvements. To sign in, users entered their postcode, which provided geographic location. Additional information recorded included height, initial weight, and stage of pregnancy or postpartum to allow appropriate feedback and to provide tailored information [27]. Other studies did not report on the tailored supportive feedback.

3.6 User Preferences for Personalisation in Pregnancy Apps

3.6.1 Personalised timeline

Most women reported that personalisation meant having access to a personalised timeline with self-monitoring and close surveillance functions (such as inputting and tracking data) to track baby's development day-by-day and week-by-week [8, 19, 28, 30]. Sourcing relevant information about pregnancy and their baby's growth and development was the most important aspect of several studies [19, 28, 30]. Data related to height, weight, sleeping, and feeding was seen as personal and thus specific to them. Informative and interactive apps in one study allowed for data input in turn providing user-tailored information, which were the most popular categories among the users (40% and 13% respectively) [8]. The responders preferred interactive apps which had the ability to store and track data and this was associated with having personalised output [30].

Women in one study expressed that they would value additional tracking technology (wearables) for themselves and their infants to receive individual personalised biometric data with a rationale that having this information in the apps would help them bond with their infants better. Additionally, women also expressed a desire for localised information that would allow them to locate mother's groups or childcare services within their area of residence. Women wanted information relevant to their issues, through user self-assessment tools, ongoing tracking of their progress, smartphone apps they could use anywhere any time, instructional video clips, monthly updates on local events and activities in their area, e-newsletters, and information tailored to the developmental stage of their child [28]. Women preferred multi-functional apps which allow them to interact with other users, as well as apps and websites with regular and up-to-date information that they require at a particular

time in their pregnancy, and at a particular time of the day [30]. Several app developers offered web-accessible content as an accompaniment to their app.

3.6.2 Viewing a baby as a person

Lupton and Thomas (2015) argued that pregnancy is *performative* in the sense that the users can modify the look and appearance of their foetus and have a choice to view foetal development week-by-week as a colourful 2D or 3D animation [28]. This, they argue, makes the foetus aesthetically appealing which is noted as a dominant feature throughout their analysis of the pregnancy-related apps. The goal of user choice here is to portray a foetus as an already autonomous communicative person, which often is a reason why pregnancy apps refer to the foetus as a baby, or offer mothers to 'interact' with their baby in a virtual space, referring to the foetus by a chosen name or nickname.

3.7 The Function of Personalisation

3.7.1 Long-lasting behaviour change, but mental health omitted

Although the impact of HYHB on behaviour change has not been investigated, Hearn et al. (2014) highlight other published research which compares personalised versus static information delivery. This evidence suggests that personalised information delivery, including tailored messages, may be more effective in leading to (long-lasting) behaviour change [24, 27]. Lupton and Pedersen (2016) noted that apps in this form provided women reassurance [30]. Hearn et al. (2014) also showed that personalised learning activities that would assist women to become role models for healthier family lifestyles (behaviour to prevent obesity) which is in line with work by Ledford et al (2016) [27, 34]. No apps mentioned anything about improved mental health outcomes, based on personalised service.

3.7.2 Strengthening the relationship with the baby and the body

Personalising an app to the women's specific needs may strengthen the 'relationship' between the women and their apps [8] which further helps them bond with their unborn foetus. In a series of studies by [19, 28] the authors were interested in how

apps 'configure pregnant embodiment'. The aim was to understand how app developers use psychology to create appealing apps that fit with the social, cultural and political norms of the users, with its primary purpose of attracting attention and boosting downloads. Personalisation in their studies was noted to be distinct depending on the purpose and function of the pregnancy app; however, the authors concluded that the role personalisation plays in pregnancy apps is purely for aesthetic and social reasons [28].

Table 3: Dimensions which make up the process of personalisation in pregnancy apps (Blom, 2000)[23][a]

Dimensions which make up personalisation as a process	How personalisation is expressed in pregnancy apps across these dimension
FUNCTIONALITY	Pregnancy and health information, tracking personal information and use of different tools, entertainment, healthcare professionals' contact details, connecting with other mothers, midwifes, nurses or even perinatal psychologists in the area
INTERFACE	Personalising personal space, the look and feel, and graphical display (user interface) of the app
INFORMATION	GENERIC: based on specific trimester TAILORED: specific health conditions of the foetus and the mother, preferred information of interest (e.g. physiology of the foetus or foods to avoid)
ACCESS	Website, app, tablet, smartphone, at any point in time/day, accessible to partners, accessible on multiple devices, accessible before or after time of birth, following first year or couple of years of baby's development and offers additional reliable advice around issues (e.g. breast feeding, incontinence), geographical location needs (consider local needs)
CONTENT	GENERIC: for all pregnant women TAILORED: based on preferences, needs (e.g. woman with endometriosis) and interests (e.g. wanting to control weight gain). Personalisation features in different forms (e.g. individual messages delivered as text messages, reminders emails, etc.)
DISTINCTIVENESS	Personalisation used for aesthetic, social needs. Personalisation used for ease of understanding and collecting personal health data. Personalisation may lead to interactivity and long –lasting behaviour change compared to static modes of information availability. Apps diminish reliance on healthcare professionals.

Source: own

4 Discussion

4.1 Principal findings

This scoping review has identified and described personalisation approaches that have been used and reported in pregnancy apps. Personalisation is one of the main

features sought by women when using pregnancy apps [11]. This review found that personalisation expresses itself mainly through the intended function(s) of the app (i.e., what the app is intended to do) and maps the process of personalisation into dimensions according to Blom's definition of personalisation [23]. Although pregnancy is a well-researched area, not many studies have offered insight into personalisation used in pregnancy-related apps, which may be due to the recency of the appearance of the technology.

4.2 Role of personalisation in pregnancy apps

Based on the included studies, most pregnancy trackers offer women an opportunity to keep track of their journey through pregnancy by tracking data such as appointments or changes in their body, as well as the development of their foetus, offer health information for any particular stage of pregnancy, and often provide personalised advice in the area of interest, such as tailored to particular woman's health status. This is in line with a recent narrative review of pregnancy apps showing that pregnancy apps were principally used to access pregnancy health and foetal development information [11]. Personalised digital health interventions demonstrated high compliance and improvements in nutrition and lifestyle behaviours [33–36]. However, pregnancy apps also offer women personalisation features that help maintain or express their identity or even the identity of their foetus. Appearance gives them a sense of familiarity (perhaps in line with social or group norms) and elicits emotional responses. This allows women to bond with their unborn baby, as studies have noted that women often felt that they were more connected to the foetus, as well as more connected to the technology and the health advice they received when they could personalise their virtual space. No studies have reported on personalisation being used in providing women with evidence-based information on the identification or management of clinical depression or anxiety which is one of the priorities set out by the British government [17, 18]. Having information in a format and at a time of need would be crucial for clinical outcomes, as well as the emotional, social and psychological well-being of children as they grow up [17, 37].

4.3 Application of findings of this scoping review

It is unclear whether the conclusions of this scoping review can be generalised to other (health) apps, but the results certainly offer an insight into the different ways

in which personalisation is expressed in this context. It would be interesting to compare the way personalisation is expressed in another set of apps (e.g., mental health apps) and develop various contextualised definitions; or, alternatively compare personalisation in different types of apps against Blom's (2000) definition of personalisation [23].

One way of extending these findings would be to study developers' perspectives toward personalisation – how they make personalisation-related decisions once developing an application, and which parameters their decisions are based on. Equally, it might also be interesting to consider the viewpoint of the healthcare professional, who supports or helps pregnant women in maternity clinics. As there are different types of pregnancy apps available and these apps employ personalisation differently, it would be interesting to examine if healthcare professionals use these apps as part of health service delivery, what is the value they expect to get from the use of these apps, and how these apps can support them in personalisation of the care process (e.g., empowering the pregnant women). This review shows that personalisation as 'appropriate responsiveness' largely means being able to access relevant and useful information at any time with a reassurance it is clinically validated and reliable with 'familiarity' and 'reassurance' being the primary psychological effects of using pregnancy apps.

4.4 Strengths and limitations

This review is limited by a very small number of papers. Except for one study being carried out in the UK as well as Australia, all studies in this review have been carried out in Australia as a country of researchers' residence. Cultural attitudes towards pregnancy and parenting differ across the world, and therefore user preferences for a) an app, and b) personalisation within it, may vary - but without data from other regions it is not possible to comment.

However, most studies included commentary or reviews of pregnancy apps available in any part of the world that offer access to the Internet. This review did not retrieve any published studies which surveyed women elsewhere in the world about personalisation features in pregnancy apps as noted in several studies. It would be beneficial and informative to consider the views of women in different geographical locations and see whether their needs and preferences for personalisation differ [38].

It is difficult to retrieve data on the total number of women using pregnancy apps

in any country as this data is very scarce. Lastly, personalisation could be used to reach women from geographically disparate groups [28], which was also noted in the study by Scalioli et al. (2015) [39].

5 Conclusions

This review found that personalisation as 'appropriate responsiveness' largely means being able to access relevant and useful information at any time with a reassurance it is clinically validated and reliable with 'familiarity' and 'reassurance' being the primary psychological effects of using pregnancy apps. The additional findings of this review warrant a further investigation into whether people from varying geographical locations and socio-cultural backgrounds have different pregnancy information needs as suggested in several other studies [39, 40]. We could not be sure that across the world, women would prefer the same personalised features. By acknowledging that personalisation plays a role in both filtering useful and relevant information as well as allowing women to engage with their baby in playful ways, future research offers an opportunity for researchers to understand how personalisation options could be included in the new digital tools for pregnancy and across different socioeconomic characteristics.

The popularity of pregnancy-related apps indicates empowerment in maternity care provision, as the availability of interactive and personalised smartphone apps may reduce women's reliance on healthcare professionals and take over some aspects of maternity care from healthcare professionals. Healthcare professionals and policymakers should therefore be aware of the popularity and wide use of pregnancy-related apps, but also of their current limitations and how these may be affecting women's behaviour around pregnancy and seeking help from healthcare providers [8]. Today, healthcare professionals need to be ready to support women with the interpretation and use of data stored or retrieved on smartphone apps.

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