The effect of a web-based intervention on perinatal emotional wellbeing and coping: A nested case-control study

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ABSTRACT

Background: WazzUp Mama© is a remotely delivered web-based tailored intervention to prevent and reduce perinatal emotional distress. The intervention has a self-help character and generates personalized feedback.
Aim: To evaluate the effect of the WazzUp Mama© intervention in a perinatal population, comparing exposure and non-exposure.
Methods: We performed a 1:3 nested case-control study including 376 participants (94 cases/282 controls), matched on core maternal characteristics. Cases received the intervention WazzUp Mama© while controls did not. The two groups were compared for depression, anxiety, and coping style/strategy mean scores, for positive Whooley items and heightened depression and anxiety scores.
Results: The number of positive Whooley items, the above cut-off depression scores, depression, and anxiety mean scores showed statistically significant differences, in favor of the intervention group. Problem-focused, emotion-focused, and passive and active coping, using informational support, positive reframing, planning, acceptance, seeking emotional support, venting, self-blaming showed statistically significant differences in favor of the intervention group. Adjusting for covariates, the statistically significant differences between cases and controls remained for all emotional wellbeing scores and for emotion-focused- and avoidant coping, seeking emotional support, venting, acceptance, and self-blame in favor of the intervention group. A history of perinatal psychological problems showed to be a confounding factor.
Conclusion: WazzUp Mama© indicates to have a significant large positive effect in optimizing perinatal emotional wellbeing, and a significant small effect on coping styles and strategies. Those who received the intervention showed a significantly lower incidence of low mood and loss of interest or pleasure, lower levels of depression and anxiety, and maladaptive coping, and significantly higher levels of adaptive coping compared with the control group.

1. Introduction

Perinatal emotional distress is experienced by six to 61 % of childbearing women, with varying prevalence rates per country (Wang et al., 2021). Perinatal emotional distress varies from a reduced sense of welfare, health and happiness, feelings of insecurity, stress, fears, and worries, to depression and anxiety and a disturbed psychological functioning from pregnancy to the first year after birth (Emmanuel & St John, 2010; Ridner, 2004). Perinatal emotional distress manifests itself during and/or after pregnancy and/or after birth and can be related, or not related, to pregnancy, birth, and early parenthood (Fontein-Kuipers, 2016). Perinatal emotional distress is associated with impaired maternal and infant health and family functioning and impaired child development (Guardino & Dunkel Schetter, 2014; Howard & Khalifeh, 2020; Rogers et al., 2020).

Pregnancy, childbirth and becoming a mother is a life-event and a unique health experience (Guardino & Dunkel Schetter, 2014; Prinds et al., 2014). Individuals respond to events in life differently, which also applies to pregnancy, birth, and early parenthood. Coping is described as the individual's behavior aimed at dealing with the demands of specific situations that are appraised as emotionally stressful and unpleasant – for example pregnancy and birth (Fisher et al., 2021; Lazarus & Folkman, 1984; Stallman, 2020). In terms of the perinatal period, maladaptive coping is associated with emotional distress but also with

physical problems, increased risk of preterm birth, and infant development difficulties, while adaptive coping helps to alleviate distress, to maintain optimal emotional wellbeing as well as it is associated with positive birth outcomes (Guardino & Dunkel Schetter, 2014). To promote perinatal emotional wellbeing and to prevent perinatal emotional distress, individual health behavior or coping behavior is an important concept (Bartholomew Eldrigde et al., 2016) - that is, maladaptive coping strategies need to change or adapt while adaptive coping strategies need to sustain or be enhanced. Using coping as a central informant for intervention development is hypothesized to optimize perinatal emotional wellbeing (Stallman, 2020). eHealth is a promising digital communication technology to promote and self-manage the perinatal emotional health of pregnant women, as well as eHealth fits nowadays pregnant women's needs to find or engage with information using digital technology (Sakamoto et al., 2022).

WazzUp Mama©

WazzUp Mama© is a remotely delivered web-based tailored intervention, aiming to prevent and reduce perinatal emotional distress. The intervention has a low-intensity character, which implies it is not provided by a specialized professional but through self-help materials (Jimenez-Barragan et al., 2023). The intervention is self-directed, requiring input from the user. Most of the intervention's content is written text. A specific program-built algorithmic recommendation system generates personalized feedback, including tip & tricks for daily life, relaxation exercises, information why, when, and how to be aware of the (warning) signs of emotional distress, advice how to adopt positive coping mechanisms and how to avoid or eliminate maladaptive adaptive coping. To self-monitor emotional distress, the stress-thermometer, the Whooley-items, and the Edinburgh Depression Scale are added to the tool. A synopsis at the end of the self-directed route provides a summary of the individual's situation and includes feedback which is tailored, based on the digitally provided responses of the individual user (Fontein-Kuipers et al., 2015a).

The intervention was initially developed for a pregnant population in the Netherlands - its development has been described in detail elsewhere (Fontein-Kuipers et al., 2015a). A needs assessment among a Dutch pregnant population showed that self-disclosure and acceptance were important coping strategies to optimize emotional wellbeing while avoidance was associated with emotional distress (Fontein-Kuipers et al., 2015b). The intervention was tested for its effect in a non-randomized pre-post intervention study, showing a moderate positive effect on emotional distress. The intervention group showed a significant reduction in the trait anxiety and pregnancy-related anxiety scores from first to third trimester of pregnancy, and a reduction of depression scores albeit not significant (Fontein-Kuipers et al., 2016). WazzUp Mama© was subsequently adapted to the contextual social and cultural emotional health needs of the Flemish perinatal population. Flanders is the northern Dutch-speaking part of Belgium bordering the southern parts of the Netherlands. Although the Flemish and Dutch population speak the same language, it could not be assumed that the Flemish perinatal population use the same coping styles and strategies as Dutch childbearing people (Manso-Córdoba et al., 2020). A similar needs assessment as in the Netherlands, showed additional adaptive coping strategies such as active coping, positive reframing, problem-solving, seeking support and religion and the maladaptive coping strategies avoidance, self-blame, self-distraction, and substance use (Brosens et al., 2023; Kuipers et al., 2019; Van Gils et al., 2022; Van den Branden et al., 2023). The findings from the needs assessment were added to the original WazzUp Mama© intervention's content, while its algorithmic recommendation system remained unchanged. The URL to WazzUp Mama© website was shared with Flemish pregnant and postpartum women via a network of practitioners, social media platforms and a multimedia campaign (August 2021–December 2022). Women could freely and anonymously access the web-based intervention using an electronic device such as tablet, computer, or mobile phone.

The aim of the present study was to evaluate the effect of the intervention WazzUp Mama© in a Flemish perinatal population by examining the differences in emotional wellbeing and coping between those who received the intervention and those who did not. We hypothesized that perinatal emotional distress scores and the use of maladaptive coping mechanisms would be lower, and the use of adaptive coping mechanisms would be higher after having used the intervention when compared with the control group.

2. Methods

2.1. Design and procedure

We performed a nested case-control study, including two groups: the intervention group who used WazzUp Mama© and the control group who received care-as-usual and thus not the intervention. Participants for both groups where eligible when 18 years of age or older and with a good comprehension of the Dutch language. Pregnant women were included during any trimester of pregnancy and postpartum women up to one year after the birth of a healthy child when have given birth between 37 and 41 weeks' gestation. Participants with children with severe illness and/or life-threatening conditions were excluded. We asked health care professionals involved in perinatal care (i.e., midwives, obstetricians, doulas, physiotherapists) to distribute flyers and posters among potential participants for both control and intervention group. We also recruited participants via various social media platforms. After the launch of WazzUp Mama©, the intervention was accessed more than 6000 times between August 2021 and December 2022. Due to General Data Protection Regulation, no IP addresses were recorded and therefore it was unknown how many unique individuals engaged with WazzUp Mama©.

2.2. Data collection

The recruitment of the participants and online data collection for the control and intervention group were carried out in two sequential periods. Data were collected in a cross-sectional way from the control group between December 2019 and March 2020 (before intervention adaptation and launch). The questionnaire link was included in posters, flyers and social media posts. Data from the intervention group was collected between January and December 2022. WazzUp Mama© had a build-in link to the questionnaire that could be completed when having followed the self-directed route of the intervention and having received the system generated personalized feedback. Women were invited to complete the questionnaire after having used WazzUp Mama© at least once. Data were collected using an online survey tool (Lime Survey©) which did not allow multiple responses.

2.3. Sample size

We used OpenEpi to calculate the sample size for the nested case-control study (https://www.openepi.com/SampleSize/SSCC.htm). The Dutch WazzUp Mama© pre-post intervention study indicated that the probability of incidence of cases with depression is 6.4 % among users of the intervention and 19.5 % among those who do not (Fontein-Kuipers et al., 2016). With a power of 80 %, α.5 and a 1:3 enrolment ratio (odds ratio 0.28), a minimum of 83 cases and 247 matched controls were needed.

2.4. Measures

We collected the following maternal characteristics and personal details: age, background (born in Belgium/not born in Belgium), highest level of education (low/medium/high), relation (in relationship/single), religion or belief, parity (nulli/primiparous or multiparous), perinatal period (pregnant/postpartum), length gestational period in weeks (categorized in first, second or third trimester of pregnancy), postpartum

period (in weeks), personal and family history of psychological problems, perinatal psychological problems (emotional problems in current or previous pregnancy and/or postpartum period), and mode of birth (spontaneous vaginal birth/instrumental birth/ operative birth). The primary outcomes of interest were low mood and loss of interest or pleasure, depression, anxiety, and coping styles and strategies.

2.4.1. Whooley questions

The two Whooley case-finding items identify potential low mood and loss of interest or pleasure. The case-finding items were answered positively (yes) or negatively (no) (Whooley et al., 1997). In a Dutch-speaking population the items showed to accurately identify depression and anxiety in first and third trimester of pregnancy (sensitivity 69–74 %; specificity 85–88 %) (Fontein-Kuipers & Jomeen, 2019). The items showed 100 % sensitivity and 65 % specificity in a postnatal population (Mann et al., 2012).

2.4.2. Edinburgh postnatal depression scale (EPDS)

The EPDS is a ten-item questionnaire to screen for the likelihood of depression among pregnant and postpartum women (Murray & Cox, 1990). Responses were scored 0–3 with a total score range from 0 to 30, a higher score indicating the seriousness of symptoms. We used validated cut-off scores ≥11 for women in the first trimester, ≥10 for women in the second or third trimester of pregnancy and ≥13 for postpartum women, showing sensitivity (70–79 %) and specificity (94–97 %) for each trimester of pregnancy (Bergink et al., 2011).

2.4.3. State-trait anxiety inventory (STAI)

The STAI is a 20-item scale identifies proneness to anxiety (Spielberger et al., 1970). We measured trait-anxiety, which is regarded as an inherent part of who a person is (Spielberger et al., 1970). Responses were scored on a 4-point rating scale (1 'not at all'; 4 'very'). Scores vary between 20 and 80. Women with scores of 41 and higher are perceived to have high levels of anxiety (Van der Ploeg et al., 1980). The Trait scale showed high concurrent validity in the pregnant validation sample (Nast et al., 2013).

2.4.4. Brief-Cope

The Brief Coping Orientation to Problems Experienced (Brief-COPE) consists of 28 items to measure individuals' adaptive and maladaptive ways of coping in response to life events (Carver, 1997). Responses were scored on a 4-point rating scale (1 = 'I haven't been doing this at all'; 4 = 'I have been doing this a lot'). A higher score indicating more use of that specific coping strategy. The Brief-COPE has three overarching coping styles: problem-focused (8 items), emotion-focused (12 items), and passive/avoidant coping (8 items). The three primary coping styles are subdivided in 14, two-item paired, coping strategies: active coping, use of informational support, positive reframing, planning, seeking emotional support, venting, humor, acceptance, religion, self-blame, self-distraction, denial, substance use, and behavioral disengagement. The Brief-COPE has been validated in a Flemish perinatal population showing acceptable to good internal consistency in a pregnant (α.70–96) and postpartum (α.61–95) population (Van Gils et al., 2022).

2.5. Analysis

We compared the characteristics of completers with non-completers (women who partially filled in the questionnaires) and characteristics of the intervention and the control group, using T-test and Chi-square. When more than 10 % values were missing per case or variable, we excluded these for further analysis. To measure between-group differences in the primary outcomes, we matched each case with three controls, reducing confounding and enhancing comparability of characteristics in the study population, with relatively minor loss in statistical efficiency (Ernster, 1994; Nielsen, 2016; Rose & van der Laan, 2009). We created identical pairs of cases and controls (1:3) based on

core characteristics known to be associated with perinatal emotional distress (Bloom et al., 2007). We measured the between-group differences with One-way ANOVA and Chi-square. We chose covariates based on the differences between completers and non-completers and between the intervention and control group characteristics. The analysis adjusting for covariates was performed with MANCOVA for continuous variables and binary logistic regression for dichotomous categorial variables. Effect sizes were calculated using Cohen's *d* and relative risk (RR). We used Statistical Package for the Social Sciences (SPSS) version 27.0 for matching and analysis.

2.6. Ethics

The study received approval from the Research and Ethics Committee Social and Human Sciences of Antwerp University (SHW_19_34). Participants digitally consented to participate before they could complete the questionnaire.

3. Results

A total of 1039 questionnaires were received from the control and 216 from the intervention group. From the responders (990/95.3 %) in the control group, 790 (76 %) completed questionnaires were eligible. From the responders in the intervention group (177/81.9 %), 94 (43.5 %) completed questionnaires could be included for analysis (Fig. 1). The completers reported significantly more often a history of emotional problems during current or previous pregnancy and/or postpartum, compared with the non-completers (*p* < .001).

3.1. Participants

Participants were most often born in Belgium, reported high levels of education and were predominantly in a relationship. Approximately a third of the participants reported a history of psychological problems. Both groups contained more nulli/primiparous than multiparous women. There were significant differences between the characteristics of the intervention and control group, being: level of education (*p* < .001), perinatal period (*p* 0.006), and gestational age (*p* < 0.001) (Table 1). During a 12-month period, the intervention group engaged between one to 12 times (mean 3.17, SD 2.43) with WazzUp Mama© before completing the questionnaire.

3.2. Primary outcomes

We constructed a data set including 376 questionnaires (1:3 matching). We created identical pairs of cases who used the intervention and controls who did not (1:3) on the following variables: maternal age, background (born in Belgium/not born in Belgium), perinatal period (pregnancy/postpartum), trimester of pregnancy when pregnant (1st, 2nd, 3rd), parity (0, 1 or more), and personal history of emotional problems (yes/no). The final data set included 94 cases and 282 controls. The matched case-control cohort showed no differences in baseline characteristics, confirmed by the Mahalanobis distances, which showed no outliers. The matching variables showed negligible correlations (*r*.01 to *r*.1).

The depression and anxiety mean scores in the intervention group were statistically significantly lower compared with the control group (*p* < .001, *d*.95; *p* < .001, *d*.84), showing a large effect. The Whooley items showed RR 0.44 and 0.42, and the above cut-off EPDS scores RR 0.21, demonstrating a statistically significant difference between cases and controls in favor of the intervention group (*p* < .001; *p* < .001; *p* < .001). This did not apply for above cut-off STAI scores RR 0.94 (*p* 1.01). The adaptive coping styles and strategies problem-focused coping (*p* < .001, *d*.49), emotion-focused coping (*p*.02, *d*.26), active coping (*p*.02, *d*.28), seeking informational support (*p* < .001, *d*.52), positive reframing (*p*.03, *d*.27), planning (*p*.02, *d*.29), seeking emotional support
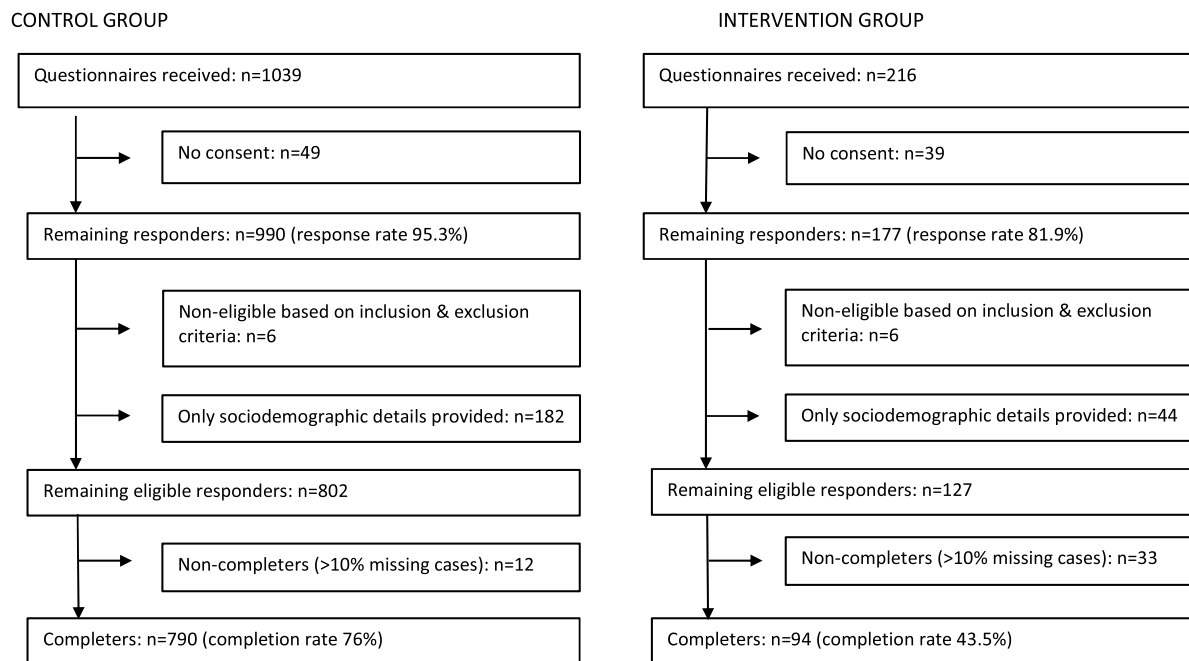
CONTROL GROUP

INTERVENTION GROUP

Fig. 1. Flowchart participants.

(p.001, d.39), venting ($p < .001$, d.4) and acceptance (p.01, d.3) scores were significantly higher in the intervention group than in the control group, showing small effect sizes in favor of the intervention group. The maladaptive coping styles and strategies avoidant coping (p.02, d.28) and self-blame (p.003, d.33) scores were significantly lower among cases compared with controls, showing a small effect in favor of the intervention group (Table 2).

When adjusting for the covariates (level of education, (history of) perinatal emotional problems, gestational age) the statistically significant differences between cases and controls remained for the EPDS and STAI mean scores ($p < .001$; $p < .001$). The Whooley items showed RR 0.66 and 0.84, and the above cut-off EPDS scores RR 0.1, demonstrating a statistically significant difference between cases and controls in favor of the intervention group (p.011; p.042; $p < .001$). Statistical differences remained for emotion-focused coping (p.03), avoidant coping (p.01), seeking emotional support (p.003), venting (p.04), acceptance (p.009) and self-blame (p.03) in favor of the intervention group (Table 3).

3.3. Post hoc analysis

A *post hoc* linear regression explained the effect of the covariates, showing a main effect for having a history of perinatal mental health problems (p.026). This was explained by maladaptive avoidant coping (R^2 0.54), and self-distraction (R^2 0.23). Exp(B) 1.0 showed no statistical differences of these coping strategies between cases and controls. No other main effects or interaction effects between the covariates were observed.

4. Discussion

WazzUp Mama© is a low-intensity remotely delivered web-based tailored intervention, showing, as hypothesized that, perinatal emotional distress and maladaptive coping mechanisms are lower, and adaptive coping mechanisms are higher after using the intervention, when compared with women who do not use the intervention. WazzUp Mama© is based on cultural contextual needs and tailored to the woman's individual situation and characteristics and based on predictive models of a Flemish perinatal population (Brosens et al., 2023; Kuipers et al., 2019; van Gils et al., 2022; Van den Branden et al., 2023) -

which might explain the positive effect of the intervention (Fontein-Kuipers et al., 2016; Guardino & Dunkel Schetter, 2014; Manso-Córdoba et al., 2020). Online supportive measures tailored to individual, country, and socio-cultural context are recognized for contributing to positive changes of perinatal emotional wellbeing (Evans et al., 2022). Freely available and easily accessible evidence-based low-intensity psychological self-help interventions are known to provide quality of emotional healthcare, supporting perinatal emotional health and wellbeing (Bower et al., 2013; Manso-Córdoba et al., 2020; NICE, 2020). Harnessing coping strategies which support perinatal emotional wellbeing may help reduce individuals needing more specialist mental health services (Fisher et al., 2021). Being aware of the short- and long-term consequences of impaired perinatal emotional wellbeing for mothers and their families (Guardino & Dunkel Schetter, 2014; Howard & Khalifeh, 2020; Rogers et al., 2020), we assume that WazzUp Mama© can potentially contribute to increasing emotional health and wellbeing and to quality of life. WazzUp Mama© can potentially reach more childbearing women (and possibly their partners) in a shorter time with less costs compared with individual trajectories (van Steensel et al., 2023). Using WazzUp Mama© during the perinatal period might offer a window-of-opportunity for long-term adaptive coping behavior in the further lifecourse (Zinsser et al., 2020). This, however, needs further research. Knowledge and understanding of the adaptive and maladaptive coping styles and strategies used by a perinatal population will benefit practitioners that are involved in the care of this population to better support them (Fontein-Kuipers et al., 2016; Zinsser et al., 2020). Additionally, the repeated positive effect of WazzUp Mama©, first in the Netherlands and now in the Dutch-speaking part of Belgium, indicates the potential to adapt the tool for perinatal populations in other countries and cultures.

The intervention showed significantly high effect sizes for emotional distress and significantly low effect sizes for adaptive and maladaptive coping styles and strategies. The sample size was sufficient to reach statistical power and to enhance validity of the findings. Therefore, it is valid to say that the effect sizes imply that the intervention is meaningful in moderating emotional wellbeing but maybe to a lesser extent in affecting change in coping. We did not reject our alternative hypothesis that maladaptive coping mechanisms are lower, and adaptive coping mechanisms are higher when using the intervention, compared with

Table 1
Demographic and personal details for control and intervention group.

	CONTROL GROUP *N* = 790		INTERVENTION GROUP *N* = 94		
	Mean (SD; range)	N /%	Mean (SD; range)	N /%	*P*
Age	30.3 (SD 3.71; 18–47)		30.29 (SD 3.12; 24–41)		.24
Background (country of birth)					.94
Belgium		740 / 93.7		89 / 94.7	
Not in Belgium		50 / 6.3		5 / 5.3	
Highest level of education*					<0.001
Low		22 / 2.8		- / -	
Medium		99 / 12.5		- / -	
High		669 / 84.7		94 / 100	
Relation					.51
In a relationship		765 / 96		93 / 98.9	
Single		26 / 4		1 / 1.1	
Religion or belief					.22
Yes		178 / 22.5		16 / 17	
No		612 /77.7		78/ 83	
Personal history of mental/psychological problems					.44
Yes		258 / 32.7		27 / 28.7	
No		532 / 67.3		67 / 71.3	
Treatment received (n = 327)					.44
Yes		201 / 77.9		23 / 71.9	
No		57 / 22.1		9 / 28.1	
Family history of mental/psychological problems					.27
Yes		282 / 35.7		30 / 31.9	
No		446 / 56.5		60 / 63.8	
Unknow		62 / 7.8		4 / 4.3	
(History of) perinatal emotional problems					.21
Yes		170 / 21.5		15 / 16	
No		620 / 78.5		79 / 84	
Perinatal period					.006
Pregnant		462 / 58.5		41 / 43.6	
Postpartum		328 / 41.5		53 / 56.4	
First-time mother		437 / 55.3		57 / 60.6	.33
More than 1 child		353 / 44.7		37 / 39.4	
Gravidity (including current/last pregnancy)	1.78 (SD 1.09; 1–10)		2 (SD 1.08; 1–6)		.76
Parity	0.94 (SD 0.81; 0–5)		1.27 (SD 0.87; 0–3)		.06

Table 1 (*continued*)

	CONTROL GROUP *N* = 790		INTERVENTION GROUP *N* = 94		
	Mean (SD; range)	N /%	Mean (SD; range)	N /%	*P*
Gestational age in weeks	24 (SD 9.88; 2–41)		36.9 (SD 1.9; 28–39)		<0.001
Weeks postpartum	20.6 (SD 14.9; 1–53)		13 (SD 12.73; 2–52)		.58
Method of birth					.42
Spontaneous vaginal birth		219 / 66.8		35 / 66	
Instrumental birth		40 / 12.2		3 / 5.7	
Primary caesarean section		28 / 8.5		6 / 11.3	
Secondary caesarean section		41 / 12.5		9 / 17	

* Low: elementary, pre-vocational secondary education; Medium: vocational secondary education (preparing for higher education); High: secondary education preparing for Bachelor(-equivalent), Master(-equivalent), university *P*-value < 0.05.

individuals who have not. However, a larger sample size or randomized study is needed to explore this further (Sullivan & Feinn, 2012). Usually, effect sizes are larger when interventions are evaluated among perinatal populations with elevated scores of emotional distress (Fontein-Kuipers et al., 2014). Because we had no baseline scores of the participants, we are unaware whether this played a role in the intervention group. A pre-post study would be required to examine this (Fontein-Kuipers et al., 2016). The low coping effect sizes might be explained by the fact that coping styles do not change much over a person's life course or during situational events such as pregnancy (Zinsser et al., 2020). Willingness to change or experiment with coping behavior and/or self-monitoring emotional wellbeing to use as goal-attainment (i.e. increase of emotional wellbeing) are known to positively affect behavior change among a perinatal population (Zissner et al., 2020). We, however, do not know to what extent this was the case among our intervention group, possibly impacting the effect sizes. We are aware that women used the intervention, on average, three times. Maybe a more frequent use of the tool could have contributed to higher effect sizes of coping. A history of perinatal psychological problems seems to play a role in the use of avoiding or eliminating maladaptive coping mechanisms (Van den Branden et al., 2023), which we also observed in this study. The participants in our study more often had a history of psychological problems during the childbirth period compared to the non-completers. This suggests we might have attracted more women with a history of perinatal psychological issues; self-selection possibly explaining the confounding effect. Due to the lack of observed statistical difference between cases and controls, it would be of merit to further explore if women with a history of perinatal emotional problems might benefit more from face-to-face delivered interventions instead of ehealth. Although the study provided us with the information that the tool moderates coping behavior during the perinatal period, an additional qualitative study would be of merit to explore intervention use among perinatal women in terms of frequency of use, fidelity to personalized feedback on coping and motivation for using the tool.

4.1. Strengths and limitations

The main challenge in this comparison is the comparability of participants in both groups (Nielsen, 2016). We were able to select controls and cases from the same population thus avoiding selection bias (Niven et al., 2013; Rose & van der Laan, 2009). Using matching, we were able to create a comparable sample of controls with respect to maternal

Table 2
Cases and controls between-group differences primary outcomes (unadjusted).

	Cases n = 94 (intervention)			Controls n = 282 (no intervention)			X2	P
	Mean (±) range	95 % CI	N/%	Mean (±) range	95 % CI	N/%		
Whooley 1[a]			28/29.8			190/67.4	42.5	<0.001*
Whooley 2[b]			18/19.1			128/45.4	21.09	<0.001*
Depression (EPDS)	5.84 (±3.93) 0–18	5.03–6.65		10.35 (± 5.4) 0–27	9.71–10.99			<0.001*
Above cut-off EPDS			9/9.6			128/45.4	39.29	<0.001*
Anxiety (STAI)	22.71 (± 11.09) 2–57	21.4–24.02		31.92 (± 10.84) 8–64	29.68–34.17			<0.001*
Above cut-off STAI			7/7.5			39/13.8	2.92	1.01
Problem focused coping	23.34 (± 3.48) 12–31	22.63–24.06		21.5 (± 4.06) 10–32	20.97–21.93			<0.001*
Emotion-focused coping	29.28 (± 3.4) 20–39	28.58–29.98		28.27 (± 4.19) 19–40	27.77–28.76			.02*
Avoidant coping	12.67 (± 2.36) 9–19	12.18–13.15		13.36 (± 2.57) 8–24	13.06–13.66			.02*
Active coping	5.89 (± 1.28) 2–8	5.63–6.16		5.53 (± 1.32) 2–8	5.37–5.68			.02*
Informational support	6.01 (± 1.38) 2–8	5.73–6.29		5.25 (± 1.56) 2–8	5.06–5.43			<0.001*
Positive reframing	5.38 (± 1.38) 2–8	5.09–5.66		5 (± 1.47) 2–8	4.83–5.18			.03*
Planning	6.06 (± 1.28) 2–8	5.8–6.33		5.67 (± 1.43) 2–8	5.5–5.84			.02*
Emotional support	6.14 (± 1.54) 2–8	5.82–6.46		5.53 (± 1.59) 2–8	5.34–5.71			.001*
Venting	5.9 (± 1.1) 3–8	5.67–6.13		5.37 (± 1.51) 2–8	5.19–5.55			<0.001*
Humor	4.27 (± 1.6) 2–8	3.94–4.6		4.21 (± 1.7) 2–8	4.01–4.41			.76
Acceptance	5.66 (± 1.13) 2–8	5.42–5.89		5.30 (± 1.23) 2–8	5.16–5.45			.01*
Religion	2.58 (± 1.16) 2–8	2.34–2.82		2.53 (± 1.22) 1–8	2.39–2.67			.73
Self-blame	4.82 (± 1.37) 2–8	4.54–5.1		5.33 (± 1.67) 2–8	5.14–5.53			.003*
Self-distraction	5.01 (± 1.22) 2–8	4.76–5.26		5.28 (± 1.28) 2–8	5.13–5.43			.07
Denial	2.55 (± 0.77) 2–5	2.39–2.71		2.66 (± 1.04) 2–6	2.54–2.79			.26
Substance use	2.23 (± 0.75) 2–6	2.07–2.38		2.32 (± 0.90) 2–8	2.21–2.43			.34
Disengagement	2.88 (± 1.19) 2–8	2.64–3.13		3.1 (± 1.18) 2–6	2.96–3.24			.13

[a] During the past month, have you often been bothered by feeling down, depressed or hopeless?.
[b] During the past month, have you often been bothered by little interest or pleasure in doing things?
  Cronbach's alpha EPDS α 0.87
  Cronbach's alpha STAI α 0.94
  Cronbach's alpha COPE-Easy α 0.78
  $F(1375) = [33.71]$, $p = <0.001$.
* $P < 0.05$.

Table 3
Cases and controls between-group differences primary outcomes (adjusted).

	Cases (intervention group)		Controls (control group)		B	P
	Mean (standard error)	95 % CI	Mean (standard error)	95 % CI		
Whooley 1[a]					1.59	.011*
Whooley 2[b]					.56	.042*
Depression (EPDS)	5.89 (0.99)	3.92–7.85	9.4 (0.44)	8.52–10.27		<0.001*
Above cut-off EPDS					.70	.03*
Anxiety (STAI)	20.76 (0.93)	18.9–22.61	35.93 (2.07)	31.83–40.03		<0.001
Above cut-off STAI					2.39	0.8
Problem focused coping	22.46 (0.87)	20.75–24.18	22.15 (0.38)	10.38–22.92		.08
Emotion-focused coping	29.29 (0.9)	27.51–31.07	28.59 (0.40)	27.79–29.39		.03*
Avoidant coping	12.57 (0.55)	11.48–13.66	13.49 (0.25)	13.01–13.98		.01*
Active coping	5.72 (0.28)	5.17–6.27	5.72 (0.13)	5.48–5.97		.06
Informational support	6.1 (0.34)	5.35–6.69	5.5 (0.15)	5.3–5.89		.06
Positive reframing	5.13 (0.31)	4.53–5.74	5 (0.14)	4.78–5.32		.65
Planning	5.59 (0.31)	5–6.33	5.79 (0.14)	5.52–6.1		.06
Emotional support	6.06 (0.33)	5.41–6.71	5.84 (0.15)	5.55–6.1		.003*
Venting	5.67 (0.32)	5.04–6.3	5.48 (0.14)	5.2–5.76		.04*
Humor	4.39 (0.37)	3.65–5.13	4.1 (0.17)	3.77–4.43		.9
Acceptance	5.63 (0.26)	5.11–6.15	5.32 (0.18)	5.18–5.64		.009*
Religion	2.68 (0.29)	2.11–3.25	2.62 (0.13)	2.37–2.88		.9
Self-blame	4.89 (0.34)	4.21–5.57	5.24 (0.15)	5.05–5.43		.03*
Self-distraction	4.89 (0.26)	4.39–5.39	5.35 (0.11)	5.12–5.57		.05
Denial	2.63 (0.21)	2.22–3.04	2.7 (0.09)	2.52–2.89		.23
Substance use	2.43 (0.21)	2.–2.85	2.4 (0.1)	2.24–2.61		.17
Disengagement	2.63 (0.24)	2.14–3.11	2.9 (0.11)	2.81–3.24		.19

[a] During the past month, have you often been bothered by feeling down, depressed or hopeless?.
[b] During the past month, have you often been bothered by little interest or pleasure in doing things?
  Adjusted for: (history of) perinatal emotional problems, level of education, gestational period: $F(1375) = [18.26]$, $p = <0.001$.
* $P < 0.05$.

characteristics. The matching variables were associated with emotional distress, increasing study precision (Bloom et al., 2007). Based on the low correlations between the matching variables, we assume the matched cohort does not lead to important bias (Nielsen, 2016; Rose & van der Laan, 2009). Nevertheless, participants in the intervention group may be different from those in the control group in other important ways that were not included in our study (Partlett et al., 2020). The choice of three controls contribute to statistical efficiency,

although cross-over between the groups was possible, affecting the matching strategy (Partlett et al., 2020). Nevertheless, the nested case-control methodology provides strong evidence for the validity of the findings because the comparison between the cases and matched controls could be made after exposure (Partlett et al., 2020). Like most studies involving self-reporting of potentially subjective experiences, social desirability can be regarded as a limitation of our study. Although participants for both intervention and control group were recruited in the same way, there was a discrepancy between the number of times the website was accessed and the number of completed questionnaires, suggesting that not all users reached the personalized feedback at the end of the self-directed route of WazzUp Mama©. Additionally, we did not utilize the full period after launching the intervention for evaluation. These aspects might have affected the sample size of the intervention group. When the intervention was introduced and evaluated, the pandemic lockdown restrictions had eased. During the aftermath of the pandemic the impact on wellbeing of families received a lot of attention (Briana et al., 2022), which might have amplified our results. Our sample contained individuals with overall high levels of education. Because the content of the intervention is text-dominated, it could be that we did not reach individuals with low literacy skills to be included in the analysis. Comparing our sample with the Flemish perinatal population, our sample shows a good representation of the population of interest in terms of maternal age, education, parity, mode of birth and history of emotional problems (Brosens et al., 2023; Goemaes et al., 2023; Kuipers et al., 2022; Van den Branden et al., 2023). The findings of our study are however only generalizable to women with similar characteristics.

5. Conclusion

This nested case-control study showed that WazzUp Mama© is an effective tool to support women in their perinatal emotional wellbeing and to moderate coping behavior. Receiving the intervention had a significant large positive effect on emotional wellbeing and a significant low effect on coping, when compared to those not receiving the intervention. Those who received the intervention showed a significantly lower incidence of low mood and loss of interest or pleasure, lower levels of depression and anxiety, lower levels of maladaptive coping, and significantly higher levels of adaptive coping compared with the control group. Development of the intervention based on predictive models and on tailoring to women's cultural contextual needs and individual needs suggest the positive effect of the intervention. Women with a history of perinatal emotional problems seem to be a more vulnerable group in terms of coping with emotional distress. The nested case-control methodology proved to be an efficient way to investigate a causal relationship between the use of WazzUp Mama© and emotional wellbeing and coping during the perinatal period.

Dutch Trial Registration TC 4688

CRediT authorship contribution statement

Yvonne J Kuipers: Conceptualization, Methodology, Validation, Formal analysis, Funding acquisition, Writing – original draft, Supervision. **Roxanne Bleijenbergh:** Writing – review & editing, Formal analysis, Data curation, Conceptualization. **Sophie Rimaux:** Writing – review & editing, Investigation, Formal analysis, Data curation, Conceptualization. **Eveline Mestdagh:** Validation, Project administration, Funding acquisition.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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