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Do pregnant women living in higher well-being populations in the USA experience lower risk of preterm delivery? A cross-sectional study

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ABSTRACT

Objective To determine if preterm birth, defined as gestational age <37 weeks, is lower for women living in counties with higher well-being, after accounting for known individual risk factors.

Design Cross-sectional study of all US births in 2011.

Participants We obtained birth data from the National Center for Health Statistics which included 3 938 985 individuals.

Main outcomes measures Primary outcome measure was maternal risk of preterm delivery by county; primary independent variable was county-level well-being as measured by the Gallup-Sharecare Well-Being Index (WBI).

Results Women living in counties with higher population well-being had a lower rate of preterm delivery. The rate of preterm birth in counties in the lowest WBI quintile was 13.1%, while the rate of preterm birth in counties in the highest WBI quintile was 10.9%. In the model adjusted for maternal risk factors (age, race, Hispanic ethnicity, smoking status, timing of initiation of prenatal visits, multiparity, maternal insurance payer), the association was slightly attenuated with an absolute difference of 1.9% (95% CI 1.7% to 2.1%; p<0.001).

Conclusions Pregnant women who live in areas with higher population well-being have lower risk of preterm birth, even after accounting for individual risk factors.

Strengths and limitations of this study

- ► In this national study, we used two large, unique datasets, including the Gallup-Sharecare Well-being Index and all data on live births in the USA in 2011 from the National Center for Health Statistics.
- ► With these data, this study was the first to examine whether the average well-being of the population in which a woman lives, defined as a broader, multi-dimensional, self-reported context of the physical, mental and social health of the geographic community, including the overall life evaluation of its residents, relates to her risk of preterm delivery.
- ► We summarised rates of preterm birth by quintile of county well-being, and tested for associations between population well-being and gestational age using hierarchical generalised linear models that adjusted for individual maternal risk factors.
- ► As a cross-sectional study, it cannot assess causation, yet determining whether a relationship exists between population well-being and risk of preterm birth is an essential first step.
- ► Without an assessment of the well-being of the individual pregnant women, the study cannot determine how population well-being may moderate the effect of women's own well-being or other related individual factors on their risk of preterm delivery.

INTRODUCTION

Despite considerable efforts, preterm birth remains a substantial public health problem in the USA.[1–3] With 1 in 10 babies born at less than 37 weeks gestation, preterm birth is the greatest contributor to infant mortality and a leading cause of long-term neurological disabilities in children, resulting in considerable mortality, morbidity and long-term costs in the USA.[4–6] Research has demonstrated that while individual factors such as maternal age and smoking status influence a pregnant woman's risk of preterm delivery,[3] community environment has additional influence.[7–9]

Research has also shown that where a woman lives affects her risk of preterm birth.

Decades of study have demonstrated that specific features of the local environment, including neighbourhood poverty, local access to healthy foods and environmental exposures, influence a pregnant woman's risk of preterm delivery.[10–14] In addition to these features, the way that the community views the overall quality of life in their community is another important, yet often unconsidered, feature of the community. Population well-being is a comprehensive construct that captures these contextual factors and incorporates community members' perceptions of the quality of their life in their community.[15 16] Well-being at the population or

community level influences health and well-being at the individual level, with a change in well-being of individuals in a community having an effect on others.[17] As such, the population well-being of a community within which pregnant women live—defined as a broader, multidimensional, self-reported context of the physical, mental and social health of the geographic community, including the overall life evaluation of its residents—may constitute a more complete and accurate conceptualisation of the environment that influences the women's risk of preterm delivery.

Higher population well-being is not only an outcome worth achieving for its own sake, but also has been associated with other desirable health outcomes, such as greater life expectancy.[18] If also associated with preterm birth, population well-being may provide a promising novel target for reducing preterm birth rates. Prior studies have examined the relationship of socioeconomic factors with preterm birth, but community well-being is a distinct construct and no study has examined whether the average well-being of the population in which a woman lives relates to her risk of preterm delivery. To address this gap, we used a comprehensive, multidimensional assessment of well-being across the USA, the Gallup-Sharecare Well-Being Index (WBI), previously known as the Gallup-Healthways WBI prior to rebranding following Sharecare's 2016 acquisition of Healthways (Gallup-Sharecare, 2011), and data on all live births in the USA in 2011 (National Center for Health Statistics [NCHS], 2011) to examine whether the rate of preterm birth varies with the overall well-being of the population within which the pregnant woman lives.[19 20] We hypothesised that risk of preterm birth is lower for pregnant women who live in higher well-being populations, even when accounting for known individual maternal risk factors. Such work lays the groundwork for testing whether society-wide interventions to improve well-being might have broad beneficial health effects.

METHODS
Overview
We conducted a cross-sectional study in which we linked data on all live births in the USA in 2011 to area-level data on population well-being. Because county was the smallest geographic area available for each mother, we aggregated well-being at the county level as well. Well-being was measured at the level of county (or county equivalent) and births were linked to the mother's county of residence. We summarised rates of preterm birth by quintile of county well-being, and tested for associations between population well-being and gestational age using hierarchical generalised linear models that adjusted for maternal risk factors.

Birth data
Birth data were obtained from NCHS.[20] The NCHS aggregates and standardises data on births collected from all 50 states and the District of Columbia. We used restricted geocoded special use files from NCHS; these include maternal risk factors, maternal county of residence and gestational age (categorised as <20 weeks, 20–27 weeks, 28–31 weeks, 32–33 weeks, 34–36 weeks, 37–38 weeks and 39, 40, 41 and 42 or more weeks). This dataset includes geocoding at the county level, using the Federal Information Processing System code.[21]

Study sample
We included all live births during 2011 where the mother's county of residence was not missing, and for which there were WBI survey responses available from that county. We excluded births with missing gestational age. In 2011, 14 states did not collect information on prenatal visits or payer (AK, AL, AR, AZ, CT, HI, MA, ME, MN, MS, NJ, RI, VA, WV). We did not impute missing data due to non-random missingness and likely confounding with the outcome. These missing variables were instead coded as unknown; in sensitivity analyses, we omitted these states.

Outcome
Our primary outcome was preterm delivery, defined as gestational age <37 weeks.[22]

Population well-being data
Our primary independent variable was population well-being. Data on population well-being were obtained from the Gallup-Sharecare WBI survey for 2011.[19] To develop the WBI, survey items that aligned with prior research on well-being were compiled by experts in the field.[23–25] Based on the existing literature, items were selected so that the survey would include both hedonic well-being (ie, people's feelings and thoughts about their lives) and eudemonic well-being (ie, an individual's judgements about the meaning and purpose in one's life).[26] The survey therefore includes items assessing daily emotional experience and a wide variety of evaluative domains, such as overall life, standard of living and satisfaction with community, work, relationships and personal health. Data from a large, representative national sample was then used to perform factor analysis to determine the final set of questions. Criterion validity of geographically aggregated data was established by examining correlations with health and socioeconomic indicators.[27] Principal component and confirmatory factor analyses were then used to create an instrument valid for measuring individual well-being. The individual well-being measure has acceptable reliability, internal and external validity.[28]

In 2011, the WBI comprised 55 self-reported items organised into six domains: life evaluation, emotional health, physical health, healthy behaviours, basic access and work environment.[24] The Life Evaluation Index measures life satisfaction and optimism about the future. The Emotional Health Index measures daily emotions and the presence or absence of depression. The Physical Health Index assesses the burden of chronic disease and recent illness. The Healthy Behaviours Index assesses the

prevalence of smoking, exercising and eating fruit and vegetables. The Basic Access Index includes perception of safety and access to housing and healthcare. The Work Environment Index assesses job satisfaction, trust and respect in the workplace and, unlike the other domains, it is collected only from the subset of respondents who report being employed. Each domain is represented by an index, measured on a scale of 0 to 100. A composite score, the WBI, is calculated as the unweighted mean of the six domain scores, and is reported on a scale of 0–100. Gallup surveyed a unique sample of nearly 1000 individuals 18 years and older every day for approximately 350 days during 2011. A structured sampling design was used with respondents surveyed from all 50 states and the District of Columbia. The survey was administered in both English and Spanish, using both land lines and cell phones. We aggregated individual WBI responses into county scores based on the maternal county of residence. For our primary analyses, we used quintiles of county WBI scores as our independent variable; in secondary analyses, we used county-level quintiles for each of the individual domain scores.

Other independent variables

From the NCHS birth dataset we included the following known maternal risk factors for preterm delivery: age (categorised as ≤19, 20–24, 25–29, 30–34, 35–39, 40+), race (white, black, Asian, American Indian/Alaska native), Hispanic ethnicity, smoking status, start of prenatal visits (first trimester, second trimester, third trimester, none, not known) and multiparity (single birth vs multiple). We also included infant sex, and, as a marker of socioeconomic status (SES), we included the maternal insurance payer (Medicaid, private, self, other, unknown).

Statistical analysis

We summarised the outcome, WBI score and all maternal risk factors by quintile of population WBI, reporting frequency and per cent of births in each category. To assess the association between population well-being and preterm birth, we estimated two individual level mixed effects linear models. Both models had the same dichotomous outcome (preterm birth) and both included a random intercept for county. Though logistic regression models are conventionally used for dichotomous outcomes, linear probability models such as these are appropriate when the outcome rate is not close to 0 or 1, and the predicted values from the model are also between 0 and 1. One advantage of using a linear model is that the intercept and coefficients have direct interpretations as a reference rate and risk differences, respectively. The first model was unadjusted, including only county quintile of population well-being. The second adjusted for maternal age, race, ethnicity, smoking status, trimester during which prenatal care was initiated, single or multiple birth, and insurance payer. For both models we calculated the Wald p value for the overall effect of WBI and a separate test for trend in effects across WBI quintiles. In secondary analyses, we replicated the main analyses using each of the six domain scores of the WBI.

We also estimated a reference model which included no independent variables, and used the county level variance from this model to calculate the variance explained at the county level for each of the models described above, using $R^2 = (\tau^2 - \tau^{*2})/\tau^2$, where τ^{*2} is the county level variance for the model with independent variables.[29]

All analyses were performed using Stata V.14.2 (2016 StataCorp).

Patient and public involvement

No patients or the public were involved in the planning and design of this study.

RESULTS

We used data from 3 938 985 births across 2989 counties, representing 99.6% of all US births in 2011. The mean (SD) county-level preterm birth rate was 11.7% (2.2%) preterm births. Table 1 shows the numbers and percentages of children born before and after 37 weeks gestation, maternal characteristics and infant sex by quintile of average well-being of the maternal county of residence.

The observed rate of preterm birth decreased across WBI quintiles from 13.1% in the lowest quintile to 10.9% in the highest quintile (table 1). In the unadjusted model, pregnant women living in counties with higher population well-being had a significantly lower risk of preterm birth, −0.2% (95% CI: −2.6 to −1.8; p<0.001) (table 2). After adjusting for maternal risk factors for preterm birth, the trend remained consistent across the quintiles; the absolute difference between the highest and lowest quintiles was attenuated to −1.9% (95% CI: −2.2 to −1.6; p<0.001). In sensitivity analyses, results were similar.

In secondary analyses, independent associations between quintiles of each well-being domain and preterm birth are reported in table 3. Similar to the composite WBI score, all domain scores were significantly associated with maternal risk of preterm birth in the unadjusted model and the model adjusting for individual maternal risk factors. Different domains, however, explained different amounts of variance of well-being, with the basic access index explaining 14.6% of the county variance. After adjusting for maternal risk factors, women in counties with the highest basic access score experienced an absolute difference in preterm birth rates of −2.4% (95%CI: −2.2% to −2.6%; p<0.001) when compared with women in counties with the lowest basic access score. Similarly, the average physical health score of the county within which a pregnant woman resided was associated with lower rates of preterm birth, in both unadjusted and adjusted models (absolute difference in preterm birth rate: −1.9%, 95% CI: −1.6% to −2.1%; p<0.001). In the models adjusted for maternal risk factors, healthy behaviours (−1.5%, 95% CI: −1.2% to −1.8%; p<0.001), emotional health (−1.0%, 95% CI: −0.7% to −1.3%; p<0.001) and life evaluation (−1.1%, 95% CI: −0.8% to −1.4%; p<0.001) of

Table 1 Gestational age at birth and maternal characteristics by maternal county quintile of composite Gallup-Sharecare Well-Being Index (WBI) score

	Total (n=3 938 985)	Q1 (n=161 964)	Q2 (n=600 373)	Q3 (n=1 212 321)	Q4 (n=1 315 547)	Q5 (n=648 780)
WBI, mean (SD)	59.6 (2.9)	64.4 (0.8)	66.7 (0.7)	68.8 (0.7)	71.5 (1.4)	67.6 (2.9)
Gestation age, N (%)						
≥37 weeks	3 477 156 (88.3)	140 703 (86.9)	524 922 (87.4)	1 067 099 (88.0)	1 164 674 (88.5)	579 758 (89.4)
<37 weeks	461 829 (11.7)	21 261 (13.1)	75 451 (12.6)	145 222 (12.0)	150 873 (11.5)	69 022 (10.6)
Mean maternal age, years (SD)	27.9 (6.0)	25.8 (5.7)	26.9 (5.9)	27.7 (6.0)	28.1 (6.1)	29.0 (5.9)
Maternal age in years, N (%)						
≤19	331 902 (8.4)	21 052 (13.0)	62 319 (10.4)	106 581 (8.8)	104 220 (7.9)	37 730 (5.8)
20–24	920 923 (23.4)	52 965 (32.7)	166 495 (27.7)	293 924 (24.2)	290 080 (22.1)	117 459 (18.1)
25–29	1 123 453 (28.5)	46 793 (28.9)	174 750 (29.1)	346 867 (28.6)	372 171 (28.3)	182 872 (28.2)
30–34	983 831 (25.0)	28 202 (17.4)	128 213 (21.4)	294 403 (24.3)	342 055 (26.0)	190 958 (29.4)
35–39	462 658 (11.7)	10 480 (6.5)	55 444 (9.2)	136 276 (11.2)	165 157 (12.6)	95 301 (14.7)
≥40	116 218 (3.0)	2472 (1.5)	13 152 (2.2)	34 270 (2.8)	41 864 (3.2)	24 460 (3.8)
Maternal race, N (%)						
White	3 010 346 (76.4)	134 126 (82.8)	437 875 (72.9)	923 217 (76.2)	1 027 093 (78.1)	488 035 (75.2)
Black	629 998 (16.0)	21 510 (13.3)	124 793 (20.8)	214 219 (17.7)	188 715 (14.3)	80 761 (12.4)
American Indian/Alaska/native American	45 035 (1.1)	4896 (3.0)	9839 (1.6)	10 900 (0.9)	12 770 (1.0)	6630 (1.0)
Asian	253 606 (6.4)	1432 (0.9)	27 866 (4.6)	63 985 (5.3)	86 969 (6.6)	73 354 (11.3)
Mother is Hispanic, N (%)						
No	2 996 684 (76.1)	146 500 (90.5)	492 335 (82.0)	897 455 (74.0)	940 278 (71.5)	520 116 (80.2)
Yes	942 301 (23.9)	15 464 (9.5)	108 038 (18.0)	314 866 (26.0)	375 269 (28.5)	128 664 (19.8)
Maternal smoking, N (%)						
No	3 400 601 (92.4)	123 008 (83.0)	475 937 (88.5)	1 066 051 (92.4)	1 175 513 (94.2)	560 092 (94.8)
Yes	278 922 (7.6)	25 218 (17.0)	61 999 (11.5)	88 132 (7.6)	72 718 (5.8)	30 855 (5.2)
Missing	259 462 (7.1)	13 738 (9.3)	62 437 (11.6)	58 138 (5.0)	67 316 (5.4)	57 833 (9.8)
Payer, N (%)						
Medicaid	1 462 567 (43.3)	72 640 (55.6)	265 707 (50.8)	487 403 (46.2)	451 382 (40.6)	185 435 (33.1)
Private	1 559 450 (46.1)	45 482 (34.8)	202 817 (38.8)	451 072 (42.8)	537 882 (48.4)	322 197 (57.6)
Self	135 125 (4.0)	5327 (4.1)	19 694 (3.8)	43 835 (4.2)	46 824 (4.2)	19 445 (3.5)
Other	165 507 (4.9)	5623 (4.3)	23 798 (4.6)	54 736 (5.2)	57 700 (5.2)	23 650 (4.2)
Unknown	57 360 (1.7)	1575 (1.2)	10 515 (2.0)	18 064 (1.7)	18 085 (1.6)	9121 (1.6)
Missing	558 976 (16.5)	31 317 (24.0)	77 842 (14.9)	157 211 (14.9)	203 674 (18.3)	88 932 (15.9)
Timing of first prenatal visit, N (%)						
1st–3rd month	2 417 154 (71.5)	88 922 (68.1)	357 044 (68.3)	750 727 (71.2)	807 186 (72.6)	413 275 (73.8)

Table 1 Continued

	Total (n=3 938 985)	Q1 (n=161 964)	Q2 (n=600373)	Q3 (n=1 212 321)	Q4 (n=1 315 547)	Q5 (n=648780)
4th–6th month	657 371 (19.4)	29 131 (22.3)	114 187 (21.9)	204 381 (19.4)	210 748 (19.0)	98 924 (17.7)
7th month–term	144 107 (4.3)	6899 (5.3)	25 691 (4.9)	44 460 (4.2)	46 204 (4.2)	20 853 (3.7)
No prenatal visit	47 479 (1.4)	1854 (1.4)	9102 (1.7)	14 963 (1.5)	16 223 (1.5)	5337 (1.0)
Unknown	113 898 (3.4)	3841 (2.9)	16 507 (3.2)	40 579 (3.8)	31 512 (2.8)	21 459 (3.8)
Missing	558 976 (16.5)	31 317 (24.0)	77 842 (14.9)	157 211 (14.9)	203 674 (18.3)	88 932 (15.9)
Infant sex, N (%)						
Female	1 922 350 (48.8)	79 125 (48.9)	293 350 (48.9)	591 407 (48.8)	642 544 (48.8)	315 924 (48.7)
Male	2 016 635 (51.2)	82 839 (51.1)	307 023 (51.1)	620 914 (51.2)	673 003 (51.2)	332 856 (51.3)
Multiple births, N (%)						
Yes	136 209 (3.5)	4789 (3.0)	19 735 (3.3)	41 606 (3.5)	45 599 (3.5)	24 480 (3.8)
No	3 802 776 (96.5)	157 175 (97.0)	580 638 (96.7)	1 170 715 (96.5)	1 269 948 (96.5)	624 300 (96.2)

the county population negatively correlated with risk of preterm birth.

DISCUSSION

In this study of nearly all births in the USA in 2011, we found that pregnant women who lived in counties with higher average well-being had significantly lower risk of preterm birth. After accounting for known maternal risk factors, including age, race, ethnicity, smoking status, timing of initiation of prenatal care, multiparity and payer type, the absolute difference in maternal risk for preterm delivery between the highest well-being counties and the lowest well-being counties was 1.9%. If this relationship is causal, and if the lowest well-being counties experienced this reduced rate, they would have had 3077 fewer preterm births in 2011 alone, yielding an estimated financial savings of nearly $160 million,[30] in addition to fewer long-term consequences of preterm birth such as infant mortality and long-term disabilities. Additional reductions in preterm birth risk in counties from the middle well-being quintiles which contributed greater total numbers of births in 2011, would augment these benefits.

Decades of research have delineated a variety of maternal-level risk factors for preterm delivery, including maternal age, smoking status, history of preterm delivery and SES,[2 3 31] while recent studies of environmental factors suggest that features of where a pregnant woman lives, including neighbourhood poverty, local access to healthy foods and environmental exposures, additionally influence her risk of preterm delivery.[10 11 13 14] Our study extends the existing literature by leveraging a large national data sources to assess how a comprehensive, multidimensional measure of population well-being, including the self-reported overall quality of life, and its various domains relate to individual preterm birth risk across the USA. In completing this study, we found that pregnant women were at lower risk of preterm delivery when living in higher well-being populations than when living in lower well-being populations, even when we accounted for maternal risk factors that are highly correlated with SES, such as insurance payer, age at time of delivery, smoking status, and timing of first prenatal visit.[32 33] This finding adds to the growing literature describing the complex interactions between individuals and their local environment, including natural, built and social environments, and their combined effects on health outcomes.

The relationship we identify could plausibly be causal through several mechanisms, including reasons related to the social environment. Pregnant women who live in higher well-being populations may experience less toxic stress, greater access to social resources, higher levels of trust and tolerance, and/or a greater perception of safety.[16] Prior research has shown that exposure to toxic stress increases the risk of preterm delivery,[34–37] while stronger social support, less social isolation and greater

Table 2 Maternal risk of preterm delivery: overall and by county of residence aggregated by quintile of composite Gallup-Sharecare Well-Being Index (WBI) score, unadjusted and adjusted for maternal risk factors

Variable	Coefficient (95% CI)	P value	Wald p	Coefficient (SE)	P value	Wald p
Intercept	0.131 (0.128 to 0.134)	<0.001		0.120 (0.118,0.123)	<0.001	
WBI score			<0.001			<0.001
Q1	ref			ref		
Q2	–	0.001		−0.006 (−0.009,−0.003)	<0.001	
Q3	−0.006 (−0.010 to 0.002)	<0.001		−0.013 (-0.016,−0.010)	<0.001	
Q4	−0.013 (−0.017 to 0.009)	<0.001		−0.014 (-0.017,−0.012)	<0.001	
Q5	−0.015 (−0.019 to 0.012) −0.022 (−0.026 to 0.018)	<0.001		−0.019 (-0.022,−0.016)	<0.001	
Maternal age						
≤19				ref		
20–24				−0.019 (-0.020,−0.017)	<0.001	
25–29				−0.021 (-0.022,−0.020)	<0.001	
30–34				−0.016 (-0.017,−0.014)	<0.001	
35–39				0.002 (0.000,0.003)	0.018	
≥40				0.023 (0.021,0.025)	<0.001	
Maternal race						
White				ref		
Black				0.051 (0.050,0.052)	<0.001	
American Indian/Native American				0.024 (0.021,0.027)	<0.001	
Asian				0.011 (0.009,0.012)	<0.001	
Mother is Hispanic						
No				ref		
Yes				0.015 (0.014,0.015)	<0.001	
Maternal smoking						
No				ref		
Yes				0.030 (0.029,0.031)	<0.001	
Unknown				0.004 (0.002,0.007)		
Payer						
Medicaid				ref		
Private				−0.019 (0.000)	<0.001	
Self				−0.012 (0.001)	<0.001	
Other				−0.013 (0.001)	<0.001	
Unknown				−0.005 (0.001)	<0.001	
Timing of first prenatal visit						
1st–3rd month				ref		
4th–6th month					<0.001	
7th month–term				−0.019 (-0.020,−0.018)	<0.001	
No prenatal visit				−0.012 (-0.014,−0.011)	<0.001	
Unknown				−0.013 (-0.014,−0.011) −0.005 (-0.008,−0.002) −0.004 (-0.006,−0.003)	<0.001	
Infant sex						–
Female				ref		
Male				0.011 (0.010,0.011)	<0.001	

Continued

Table 2 Continued

Variable	Coefficient (95% CI)	P value	Wald p	Coefficient (SE)	P value	Wald p
Multiple births						
No				ref		
Yes				0.487 (0.485,0.489)	<0.001	
R^2	0.078			0.656		

GHWBI, Gallup-Sharecare Well-Being Index.

social connectedness are associated with lower risk of preterm delivery, perhaps by reducing the allostatic load or chronic stress experienced by pregnant women.[38–43] Additionally, while experiences of perceived discrimination are associated with increased risk of preterm delivery, experiences of trust and tolerance as well as a greater perception of safety may foster healthier pregnancies and term deliveries.[44–46]

According to our results, pregnant women with the same individual maternal risk profile, including factors associated with SES, experience lower risk of preterm delivery when living in higher well-being populations than when living in lower well-being populations. This finding is consistent with emerging epigenetics[13 47 48] and maternal weathering[24 29] literature. The maternal weathering model suggests that certain populations of women have an increased risk of preterm delivery due to 'accelerated ageing' that they experience as a result of greater exposure to hardship. This model suggests that living in better neighbourhoods might attenuate the increased risk associated with these weathering effects.[49] It is possible that the observed risk contributed by weathering and the risk mitigated by living in higher well-being populations are actually related to underlying exposure to toxic stress and buffering from factors such as trust, tolerance, social support and perceived safety.

Our study also builds on prior literature that found links between living in areas of greater poverty and increased risk of preterm birth. In the domain analyses, the basic access domain demonstrated the strongest relationship with maternal risk of preterm delivery. Even after adjusting for individual maternal risk factors, including insurance provider and smoking, the basic access domain explained nearly 15% of county-level variance in preterm birth rates. The basic access index domain includes items that assess perceived access to healthcare, clean water, fresh produce and safe public space as well as ability to afford basic needs such as food and shelter. This finding affirms prior literature reporting that access to basic needs is strongly correlated with health outcomes. Importantly, however, all domains contributed independently to the inverse association between population well-being and maternal risk of preterm delivery, though to varying degrees. Average county-level physical health, healthy behaviours and emotional health scores were associated with a 1%–2% lower maternal risk of preterm delivery.

The results of our study have several potential implications. Our findings suggest the possibility that effective population-level and community-level investments in well-being may not only improve overall health and quality of life for populations, but also contribute to reduced rates of preterm birth for pregnant women living in those populations, an idea worth pursuing. Our domain analyses suggest that improving aggregate basic access, in particular, could plausibly result in not only greater well-being but also fewer preterm births. Targeting other domains, such as physical health, healthy behaviours and emotional health, may yield additional improvements. Importantly, the effectiveness of various interventions will most likely depend on the contexts within which they are implemented. Currently, efforts are under way across the globe to track and improve population well-being through programmatic and policy-based interventions.[4 6 50–52] While some interventions involve multisector, community-based programmes, many of which are government supported, other interventions involve changes in economic and social policies, such as those aimed at affordable housing, employment and access to public spaces for physical fitness or social connection.[16 53 54] Given the relationship between population well-being and preterm birth risk, examining the association of such programmes and policies with preterm birth could be informative and allow for spread of interventions that effectively increase well-being and reduce preterm birth.

Our study has limitations. First, as a cross-sectional study, it cannot assess causation. However, determining whether a relationship exists between population well-being and risk of preterm birth is an essential first step. Second, this study specifically examines how the average well-being of the adult population within which a pregnant woman lives correlates with her risk of preterm delivery. Because we do not have an assessment of the well-being of the individual pregnant women, we cannot determine how population well-being may moderate the effect of women's own well-being or other related individual factors on their risk of preterm delivery. Additionally, we did not have data on maternal income, wealth or education level, so we could not directly adjust for these socioeconomic variables. Nevertheless, we used available maternal-level variables that are known to be associated with SES as proxies in order to control for the effect of SES on preterm birth

Table 3 Maternal risk of preterm delivery by county of residence aggregated by quintile of individual Gallup-Sharecare Well-Being Index domain scores, unadjusted and adjusted for maternal risk factors

Variable	Unadjusted model			Adjusted model		
	Coefficient (95% CI)	P value	Wald p	Coefficient (95% CI)	P value	Wald p
Basic Access Index			<0.001			<0.001
Q1	ref			ref		
Q2	−0.012 (−0.016 to 0.009)	<0.001		−0.009 (−0.012 to 0.006)	<0.001	
Q3	−0.021 (−0.024 to 0.017)	<0.001		−0.015 (−0.017 to 0.012)	<0.001	
Q4	−0.027 (−0.031 to 0.024)	<0.001		−0.019 (−0.022 to 0.016)	<0.001	
Q5	−0.034 (−0.037 to 0.030)	<0.001		−0.024 (−0.027 to 0.021)	<0.001	
R^2	0.146			0.656		
Physical Health Index			<0.001			<0.001
Q1	ref			ref		
Q2	−	<0.001		−0.007 (−0.010 to 0.005)	<0.001	
Q3	0.009 (−0.012 to 0.005)	<0.001		−0.013 (−0.015 to 0.010)	<0.001	
Q4	−0.013 (−0.016 to 0.009)	<0.001		−0.017 (−0.019 to 0.014)	<0.001	
Q5	−0.017 (−0.020 to 0.013)	<0.001		−0.019 (−0.021 to 0.016)	<0.001	
	−0.019 (−0.023 to 0.016)					
R^2	0.059			0.657		
Healthy Behaviours Index			<0.001			<0.001
Q1	ref			ref		
Q2	−0.003 (−0.007 to 0.001)	0.13		−0.005 (−0.008 to 0.002)	<0.001	
Q3	−0.008 (−0.011 to 0.004)	<0.001		−0.010 (−0.013 to 0.008)	<0.001	
Q4	−0.013 (−0.017 to 0.010)	<0.001		−0.015 (−0.017 to 0.012)	<0.001	
Q5	−0.017 (−0.021 to 0.013)	<0.001		−0.015 (−0.018 to 0.012)	<0.001	
R^2	0.039			0.654		
Emotional Health Index			<0.001			<0.001
Q1	ref			ref		
Q2	−0.011 (−0.014 to 0.007)	<0.001		−0.010 (−0.013 to 0.008)	<0.001	
Q3	−0.012 (−0.015 to 0.008)	<0.001		−0.011 (−0.014 to 0.009)	<0.001	
Q4	−0.014 (−0.018 to 0.010)	<0.001		−0.013 (−0.016 to 0.010)	<0.001	
Q5	−0.012 (−0.016 to 0.008)	<0.001		−0.010 (−0.013 to 0.007)	<0.001	
R^2	0.032			0.656		
Life Evaluation Index			0.004			<0.001
Q1	ref			ref		
Q2	−0.005 (−0.009 to 0.001)	0.01		−0.005 (−0.008 to 0.002)	<0.001	
Q3	−0.006 (−0.009 to 0.002)	0.004		−0.008 (−0.011 to 0.005)	<0.001	
Q4	−0.006 (−0.009 to 0.002)	0.003		−0.010 (−0.013 to 0.007)	<0.001	
Q5	−0.008 (−0.011 to 0.004)	<0.001		−0.011 (−0.014 to 0.008)	<0.001	
R^2	0.004			0.653		
Work Environment Index			<0.001			<0.001
Q1	ref			ref		
Q2	−0.007 (−0.011 to 0.003)	<0.001		−0.008 (−0.010 to 0.005)	<0.001	
Q3	−0.008 (−0.012 to 0.004)	<0.001		−0.009 (−0.011 to 0.006)	<0.001	
Q4	−0.010 (−0.013 to 0.006)	<0.001		−0.007 (−0.010 to 0.005)	<0.001	
Q5	−0.006 (−0.010 to 0.002)	0.002		−0.003 (−0.006 to 0.000)	0.001	
R^2	0.016			0.653		

and isolate the effect of community well-being. Finally, we did not have well-being data available at geographically smaller units (eg, neighbourhood or city) which may be more relevant than county well-being in describing the community context for an individual pregnant woman. While counties are distinct from the smaller, often more homogeneous, geographic units of neighbourhoods and census tracts, policies and programmes are often enacted at the county level. Thus, results may drive action at the county-level, while also informing local communities in developing targeted programmes to enhance well-being.

Pregnant women who live in populations with higher well-being have lower risk of preterm delivery, even after accounting for known individual maternal risk factors. The well-being of a population is an important end itself, but if causal pathways exist between population well-being and other valued outcomes, investments in population well-being may yield other benefits, potentially including fewer preterm births. Understanding the full effects of population well-being can inform the emerging dialogue about its value as a health investment.

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