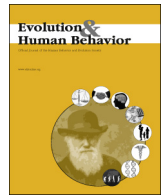




Contents lists available at ScienceDirect

## Evolution and Human Behavior

journal homepage: [www.ehonline.org](http://www.ehonline.org)

## Original Article

The expression and adaptive significance of pregnancy-related nausea, vomiting, and aversions on Yasawa Island, Fiji<sup>☆</sup>Luseadra Mckerracher<sup>a,\*</sup>, Mark Collard<sup>a,b</sup>, Joseph Henrich<sup>c,d</sup><sup>a</sup> Department of Archaeology and Human Evolutionary Studies Program, Simon Fraser University, EDB 9635 8888 University Dr., V5A 1S6, Burnaby, BC, Canada<sup>b</sup> Department of Archaeology, School of Geosciences, Meston Building, University of Aberdeen, AB24 3UE, Old Aberdeen, Scotland<sup>c</sup> Departments of Psychology and Economics, 2136 West Mall and 1873 East Mall, University of British Columbia, V6T 1Z1, Vancouver, BC, Canada<sup>d</sup> Canadian Institute For Advanced Research, 180 Dundas W, M5G 1Z8, Toronto, ON, Canada

## ARTICLE INFO

## Article history:

Initial receipt 24 March 2014

Final revision received 25 September 2014

Available online xxx

## Keywords:

Nausea and vomiting of pregnancy (NVP)

Aversions

Reproductive ecology

Diet

Pathogen/Teratogen avoidance

Small-scale society

Fiji

## ABSTRACT

We report a study on nausea and vomiting of pregnancy (NVP) and pregnancy-related food aversions in a small-scale society from Yasawa Island, Fiji. Because NVP has rarely been studied quantitatively in small-scale populations, we begin with a detailed description of its expression among the women of Yasawa. We found that 66% of these women experience nausea and/or vomiting in tandem with the development of aversions to certain foods. This pattern of expression is similar to what has been documented for industrialized populations, and the prevalence of 66% is close to the industrialized mean prevalence of 69%. We then use the data from the women of Yasawa to evaluate the three main hypotheses that have been put forward to explain the evolution and ecological function of NVP. We show that food aversions of pregnancy focus preferentially on food types that are more likely to carry pathogens or contain chemical toxins. Such aversions do not focus on nutrient-dense foods or on frequently encountered foods. These findings are most consistent with the hypothesis that NVP, along with pregnancy-related aversions, evolved to motivate women to avoid exposure to diseases and other toxins when they are immune-compromised by pregnancy and during a critical period of embryo development. These findings contribute to a growing body of theoretical and empirical literature that suggests that NVP symptoms represent a series of adaptations rather than pathological responses to the physiological demands of pregnancy.

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## 1. Introduction

Sometimes called “morning sickness” or “pregnancy sickness”, Nausea and Vomiting of Pregnancy (NVP) refers to a suite of symptoms that many women experience to varying degrees and in varying combinations during early pregnancy. These symptoms include nausea, gagging, retching, vomiting, dizziness, and fatigue (Firoz, Maltepe, & Einarson, 2010). Increased olfactory sensitivity (Nordin, Broman, Bringlov, & Wulff, 2007; Nordin, Broman, & Wulff, 2005) and the development of novel aversions to specific foods, social situations, and/or sexual behaviors (Fessler, Eng, & Navarrete, 2005; Navarrete, Fessler, & Eng, 2007; Young & Pike, 2012) generally accompany NVP and appear to relate to it both temporally and functionally (Patil, Abrams, Steinmetz, & Young, 2012).

Currently, NVP is thought to affect approximately 60% of women during at least one of their pregnancies (Flaxman & Sherman, 2000). However, this prevalence estimate is based largely on Western populations (Patil et al., 2012) and therefore may be inaccurate. Western food production and health care systems differ substantially from those in many other places, and these factors may influence NVP expression. Significantly, the limited evidence from populations from a more diverse range of countries suggests that NVP prevalence varies cross-culturally (Einarson, Piwko, & Koren, 2013; Pepper & Roberts, 2006) and that some non-Western populations have lower rates than have been documented for Western nations (e.g. Anath & Rath, 1993; Christian et al., 1998).

NVP is puzzling from an evolutionary perspective (Fessler, 2002b; Flaxman & Sherman, 2000) because the expression of the appetite-suppressing features of NVP in early pregnancy (e.g. nausea, vomiting, and food aversion) limits maternal and fetal access to energy and other nutrients that promote fetal growth (e.g. Latva-Pukkila, Isolauri, & Laitinen, 2010; Lee, Lee, & Lim, 2004). Despite these costs, however, such symptoms are associated with reduced risk of spontaneous abortion (Forbes, 2002; Huxley, 2000), and increases in NVP severity correlate with improved outcomes in other measures of fetal survivorship and in infant and young child health (e.g. Latva-Pukkila et al., 2010; Nulman et al., 2009; Weigel & Weigel, 1989). This counter-intuitive pattern raises two important questions. First, is NVP a feature of most healthy, non-abortive human pregnancies regardless of ecological context or is it an

<sup>☆</sup> We gratefully acknowledge the contributions of a number of organizations that supported this research. LM receives support from the Social Sciences and Humanities Research Council of Canada (SSHRC) and Simon Fraser University (SFU). MC is funded by the Canada Research Chairs Program (CRC), the Canada Foundation for Innovation, the British Columbia Knowledge Development Fund, SSHRC, and SFU. JH is supported by SSHRC, CRC, the Canadian Institute for Advanced Research and New York University's Stern School of Business.

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anomaly of industrial socioeconomic systems? Second, if NVP affects most populations, why might it have a positive rather than a negative impact on pregnancy outcome?

Here, we report a study designed to address these questions. The study focused on an indigenous population of small-scale fisher-farmers from Yasawa Island, Fiji. In the first section of the study, we used recall-based interview data from women of Yasawa Island to generate summary statistics regarding the expression of NVP and related symptoms in this population, and then compared these statistics to those documented for other populations. In the second part of the study, we used the interview data to test the three main hypotheses that have been proposed to explain why NVP might have evolved despite its costs. The study, which is among the first to systematically assess NVP in a small-scale society, supports the hypothesis that NVP is a feature of the majority of healthy human pregnancies, and suggests that it evolved to protect the developing fetus from exposure to pathogens and chemical toxins.

## 2. Data collection

The data were collected in 2005–2006 as part of an on-going project led by one of us (JH) on the lifeways, psychology, culture, and evolutionary ecology of a population indigenous to Yasawa Island, Fiji.

Yasawa, situated on the northwestern edge of the Fijian archipelago, has a seasonal climate, featuring a hot, wet season, and a relatively mild, dry season. The island is home to ~900 people who live in six villages. The majority of Yasawans are subsistence-level fisher-horticulturalists (Henrich & Broesch, 2011; Henrich & Henrich, 2010). Subsistence is based heavily on cultivated root vegetables (primarily cassava and yams), cultivated fruits (primarily coconuts and bananas), gathered shellfish and other littoral resources, fish, and some imported processed foods (primarily tea, sugar, and wheat flour). Men maintain garden plots and fish, while women gather wood and littoral resources, prepare food, provide childcare, and carry out most other household tasks. Children assist with gathering and childcare. Additional information regarding the study site and the participants is provided in the supplementary materials (S Text 1).

Trained female Fijian field assistants interviewed 70 mothers from randomly sampled households in three Yasawan villages about nausea, vomiting, and related sensations, a phenomenon called “*kuna ca*” in Standard Fijian. Specifically, mothers were asked whether they had experienced *kune ca* during their most recent full term pregnancies and, if so, during what months they had experienced it. They were also asked to freely list any symptoms of pregnancy they could recall. Subsequently, they were asked if they experienced any of the following: nausea, vomiting, headache, dizziness, loss of appetite, or diarrhea. Women were also asked about food aversions during the interview. The interviewers asked women to freelist any items they normally like but found aversive during pregnancy. Then, women were asked if any of the following foods became aversive during pregnancy: shellfish, fish, meat, vegetables, fruit, dairy products, sweets, spices, cassava, yams, turtle, moray eel, octopus or squid, porcupine fish, freshwater eel, barracuda, and shark. Additionally, because in pilot interviews women had spontaneously reported novel aversions to their husbands, each interviewee was asked if the smell of her husband bothered her during her pregnancy.

Twenty randomly selected female heads of households were also interviewed about the composition of their households’ diets.

All interviews were carried out in standard Fijian and subsequently translated to English before coding and analyses.

## 3. Part I: expression of NVP on Yasawa, and comparison to global sample

The first part of this study had two aims. The first was to diagnose and characterize NVP and related symptoms among the women of

Yasawa Island. The second was to compare the proportion of women from Yasawa that experience NVP to NVP prevalence in other populations from around the globe.

We describe expression of NVP on Yasawa in detail because, although ethnographers have previously reported anecdotes of pregnant women in small-scale societies experiencing nausea and vomiting, these reports do not tell us how frequently the phenomenon occurs in such populations (Flaxman & Sherman, 2000; Minturn & Weiher, 1984). To our knowledge, only one previous study, carried out by Pike (2000) on Turkana pastoralists of Kenya, has investigated prevalence of NVP in a small-scale society. So, our study provides one of only two pieces of quantitative evidence that NVP is a common feature of pregnancy in subsistence-level populations.

We used both the freelist data and the checklist data regarding NVP symptoms to retrospectively diagnose women with NVP following the differential diagnosis guidelines outlined for Western clinical populations by Firoz et al. (2010), independent of whether the women self-diagnosed with *kune ca*.

Our main findings regarding the rates at which the women of Yasawa Island experience NVP-related symptoms are summarized in Table 1. We found that, of the 70 women interviewed, 47 (67%) reported having experienced *kune ca* in their most recent pregnancies. Of these, we diagnosed 46 (66% of the sample) with NVP, according to Firoz et al.’s (2010) guidelines. None of the women who reported not experiencing *kune ca* had clinical NVP symptoms. All 46 (100%) women with NVP reported having vomited at least once and 44 (96%) of them reported having felt nauseous. Many of these same women also reported other uncomfortable symptoms during their pregnancies, including loss of appetite (98% of those with NVP), headaches (85%), and/or diarrhea (15%).

Regarding the timing of NVP, 19 (41%) of the 46 women with NVP reported that they experienced nausea and vomiting exclusively in the first trimester of their pregnancies, 31 (67%) during the first four months, and 42 (93%) during the first two trimesters.

All of the women with nausea and vomiting developed at least one novel food aversion during their pregnancies. We also found that 19 (41%) of the 46 Yasawan women with NVP became averse to the smell of their husbands during their pregnancies.

Thus, the data strongly suggest that NVP exists on Yasawa. The expression of *kune ca* on Yasawa is consistent with how NVP has been described for other populations. That is, nausea and vomiting often occur with one another and with some combination of headaches, fatigue, dizziness, and the development of novel aversions, primarily during the first three to four months of pregnancy (Firoz et al., 2010; Flaxman & Sherman, 2000; Patil et al., 2012). Our main unexpected finding was that many Yasawan women were strongly averse to the smell of their husbands during pregnancy; this phenomenon has only been documented anecdotally previously (see Steinmetz, Abrams, & Young, 2012: p. 424).

**Table 1**

Summary statistics for *kune ca* prevalence, and specific NVP symptoms including nausea, vomiting, headache, dizziness, fatigue, food aversions, husband aversions among the women of Yasawa Island.

Symptoms (S) and Correlates (R) of NVP	Number of women in sample with symptom	% of women in sample with symptom
Nausea (S)	44	63%
Vomiting (S)	46	66%
Headache and/or dizziness (S)	34	47%
Diarrhea (R)	7	10%
Loss of Appetite (R)	45	64%
Food Aversions (R)	68	97%
Aversions to smell of husband (R)	19	41%
Report <i>Kune ca</i>	47	67%

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