






Scoping Review

Knowledge, attitude and practices of health professionals with regard to plant-based diets in pregnancy: a scoping review

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Abstract

Objective: This scoping review aimed to systematically map and describe the existing evidence regarding the knowledge, attitudes and practices of health professionals with regard to plant-based diets during pregnancy and to highlight areas for further research.

Design: Following a pre-registered protocol, online databases were searched using a comprehensive search string, in addition to selected grey literature sources, and reference lists of included studies. The studies were independently screened for eligibility by two authors, SM and JM. Data from all eligible studies were charted by the first author, and a narrative summary was performed.

Setting: Maternal health care services.

Results: Ten studies were included for review, from New Zealand (*n* 2), Australia (*n* 2), Germany, Netherlands, United Kingdom, France, Italy and Peru. Most of these studies were observational, employed various validated and non-validated survey instruments, interviews and one education intervention. Knowledge was the most frequently assessed outcome in the reviewed studies. Health professionals' knowledge of plant-based nutrition in pregnancy was reported to be limited and frequently attributed to a lack of nutrition training. Participants' personal dietary patterns and work specialisation appear to be closely associated with their knowledge, attitudes and practices regarding plant-based diets.

Conclusion: This review identified a significant research gap regarding health professionals' practices in relation to plant-based diets during pregnancy. Additionally, this review has demonstrated the need for further research, awareness and practice protocols to promote high-quality care and education or professional development to address the prevalent lack of knowledge among this group.

Keywords
Knowledge
Attitudes
Practices
Plant-based diets
Pregnancy

Diet is a critical factor in pregnancy⁽¹⁾. Adequate intake of macro- and micro-nutrients, along with heightened food safety practice, is pivotal for maternal and fetal health. In addition to efforts to satisfy nutritional and food safety guidelines, pregnant individuals navigate physiological changes, such as nausea, vomiting, cravings and aversions, all of which can have major impact on one's appetite and eating behaviour⁽²⁾. Globally, interest in plant-based dietary patterns and products appears to be increasing among consumers⁽³⁾ and public health organisations (e.g. The National Heart Foundation of New Zealand⁽⁴⁾), driven

by increasing awareness of health and sustainability (e.g. the EAT-Lancet diet⁽⁵⁾). Plant-based diets (PBD), broadly defined as a spectrum of diets restricting the intake of animal products⁽⁶⁾, can potentially add further burden for pregnant individuals to meet a healthy diet for pregnancy.

While empirical evidence remains scarce, recent data from New Zealand (*n* 47 000) suggest 5.8% of individuals identify as vegan or vegetarian⁽⁷⁾ – a dramatic increase over the 1% reported by the 1997 New Zealand National Nutrition Survey (Russell et al. 1999). Globally, the reported prevalence of individuals following PBD varies

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from 1.8% in Finland⁽⁸⁾ to 29% of women in India⁽⁹⁾. The growing popularity of PBD, particularly among females of reproductive age^(10,11), demands a better understanding of PBD during pregnancy, from both nutritional and behavioural perspectives.

Lack of adherence to national dietary guidelines during pregnancy is an ongoing public health challenge. In a cohort study of 5664 pregnant individuals in New Zealand, only 3% completely met the Ministry of Health food intake guidelines⁽¹²⁾, with similar low-adherence observed globally^(13,14). Although pregnant plant-based following populations are yet to be rigorously studied, clinical evidence suggests these individuals frequently experience sub-optimal nutritional status compared with omnivores; for example, dietary Zn intake during pregnancy was significantly lower among those following vegetarian diets⁽¹⁵⁾, and a longitudinal cohort study found up to 39% of vegetarians experienced vitamin B₁₂ deficiency in at least one trimester of pregnancy⁽¹⁶⁾. These data, along with evidence from non-pregnant, plant-based populations, demonstrate the need for healthcare systems to better support pregnant individuals consuming PBD.

Pregnant women are highly health-motivated, driven to achieve positive health and developmental outcomes for themselves and their infant^(17,18). Evidence suggests pregnant individuals consider health professionals to be important sources of nutrition information^(18,19), and nutritional counselling could have a positive effect on diet and maternal health outcomes, particularly among developing countries⁽²⁰⁾. Health professionals in regular contact with their pregnant patients are well placed to encourage healthy dietary patterns during pregnancy. In plant-based pregnancies, where individuals may require more support to achieve a well-planned diet, further importance is placed on the role of health professionals to help facilitate this. Although there is not yet a global, systematic evaluation of nutritional training for health professionals, available evidence from medical education suggests the curricula do not enable health professionals to give appropriate nutritional advice⁽²¹⁾.

The knowledge, attitudes and practices theoretical framework, frequently utilised in public health research, can provide broad insights into a topic or phenomena of interest⁽²²⁾. However knowledge, attitudes and practices research regarding health professionals in the context of plant-based diets and pregnancy is scarce; recent evidence suggests health professionals' knowledge of PBD in pregnancy is limited⁽²³⁾, and few studies have investigated attitudes or practices⁽²⁴⁾. Therefore, a scoping review was conducted, utilising a diverse range of evidence sources to identify and map available evidence, identify gaps in the existing literature and shed light on reoccurring factors or characteristics related to the following research questions⁽²⁵⁾: What is known from the literature about the knowledge, attitudes and practices of health professionals regarding PBD in pregnancy? Does the knowledge and

Table 1 Definition of plant-based diets

Dietary pattern	Definition
Omnivorous Plant based ^(26,27)	No restrictions on animal products Predominantly foods of plant origin, minimal intake of foods of animal origin
Flexitarian, semi-vegetarian	Reduced or selective meat consumption and includes fish, eggs and dairy
Pesco-vegetarian	Excludes meat except fish and seafood and includes eggs and dairy
Vegetarian	Excludes meat and fish and may include eggs or dairy
Ovolacto-vegetarian	Excludes meat and fish and includes eggs and dairy
Lacto-vegetarian	Excludes meat, fish and eggs and includes dairy
Ovo-vegetarian	Excludes meat, fish and dairy and includes eggs
Vegan/Strict vegan	Excludes all foods of animal origin and includes honey

practices of health professionals in the reviewed studies align with relevant national dietary guidelines?

Method

Definitions

Recent interest from the scientific community has highlighted the need for clarity regarding the definitions of PBD. This review defines PBD as a continuum of dietary preferences⁽⁶⁾, whereby an individual's dietary energy obtained from animal sources is minimal, and compensated for by plant-based foods^(26,27). PBD include dietary patterns such as vegan, vegetarian, and in some cases, semi-vegetarian, flexitarian, Mediterranean and some traditional or ancestral diets^(26,27), outlined in Table 1.

Protocol and registration

Following a preliminary search of PROSPERO, MEDLINE, the Cochrane Database of Systematic Reviews and JBI Evidence Synthesis, no current or in-progress systematic or scoping reviews on the topic were identified. A protocol document was then developed following the Joana Briggs Institute methodology for scoping reviews^(28,29), with reporting guided by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses, Scoping Reviews extension checklist⁽³⁰⁾. The protocol was registered with the Open Science Framework (<https://doi.org/10.17605/OSF.IO/S97PX>) prior to commencing the study and was unaltered during the course of the study.

Information sources, eligibility criteria and search

An initial search of Web of Science and MEDLINE (Ovid) identified key words used in the title, abstract and index terms of relevant papers. These informed the search strategy for the following, additional bibliographic

Table 2 Inclusion and exclusion criteria for publications included in review

Study characteristic	Inclusion criteria	Exclusion criteria
Population	Health professionals providing care during any stage of pregnancy, e.g. obstetrician, nurse, fertility specialist, dietitian, midwife, general practitioner, emergency medicine, pharmacist, psychologist, counsellor, etc.	Not health professionals Animal studies
Condition	PBD and pregnancy	PBD in nonpregnant individuals, Omnivorous diets during pregnancy
Outcomes	Knowledge, attitudes, practices, awareness and training needs of the study cohort in relation to PBD in pregnancy	

PBD, Plant-based diets.

databases, searched on 20 June 2023: Embase (Ovid), PsycInfo (Ovid), Global Health (Ovid), Scopus, CINAHL (EBSCO), Health and Medical Collection (ProQuest) and Dissertations and Theses Global (ProQuest). Search strings used are available in Appendix A. Grey literature sources were searched using an adapted search string, including university research repositories in New Zealand, reference lists of included publications and the first 100 results on Google Scholar. The search was restricted to reports published in the English language due to limited resources for accurate language translation, and reports published in the past 30 years, due to changing healthcare systems and the relatively recent interest in PBD. Identified records were exported via EndNote v.20 (Clarivate Analytics, PA, USA) to Rayyan (Qatar Computing Research Institute, Doha, Qatar) for screening by two authors, SM and JM.

Selection of sources of evidence

SM and JM independently screened study titles and abstracts against the criteria presented in Table 2. Abstracts that appeared to meet the inclusion criteria were retained for full text screening. Full texts were independently retrieved by SM and JM and screened against the inclusion criteria. Any disagreements were discussed and resolved upon completion of the screening process. SM manually searched the reference lists of the included studies for any relevant reports, which were then subject to the same screening procedure.

Data charting process

SM completed data charting independently, using an instrument adapted from JBI⁽²⁹⁾. The following variables were charted: year, authors, title, geographic location, study design, primary aim of the study, methodology, number of participants, roles of health professionals, plant-based dietary patterns referenced and definitions, participant's own dietary pattern, knowledge of PBD nutrition in pregnancy, attitudes towards PBD in pregnancy and practices regarding pregnant individuals following PBD (for example, early testing for Fe deficiency). When not explicitly defined, attitudes were interpreted as questions

pertaining to beliefs, expectations or opinions. Qualitative data were charted using a deductive approach, with knowledge, attitudes and practices as the pre-decided categories^(31,32). The included studies were assessed for quality using the Mixed Methods Appraisal Tool⁽³³⁾. This optional step was included to enable a more in-depth exploration of the reported results. Lastly, a narrative synthesis was performed, grouping the data by knowledge, attitudes and practices.

Results

A total of 3057 articles were found. Of these, 1698 were duplicates and were excluded by automatic detection (n 1053) and after review by SM (n 645). SM and JM independently screened the remaining 1359 articles against the inclusion and exclusion criteria, based on study title and abstract. Seventy-five articles were eligible for full-text screening, of these, 10 were included for review as outlined in Fig. 1. The remaining sixty-five articles were excluded for not being published in English language (n 1), not assessing PBD in pregnancy (n 31), study participants were not health professionals (n 6), study was a review, opinion piece or practice guideline (n 25) and for being published prior to 1993 (n 2). One study was excluded at the data charting stage, due to the results not being relevant to the current review, and one additional study was included after citation searching.

All studies were published between 1995 and 2022, although the majority were published in the last 5 years. Despite diverse geographic locations of these studies, including five from European countries (Netherlands, Germany, Italy, France and United Kingdom) (n 5)^(23,24,34–36), four from the Oceania region (Australia (n 2) and New Zealand (n 2))^(37–40) and one from Latin America (i.e. Peru)⁽⁴¹⁾, it is important to note that these countries may share similar westernised dietary patterns⁽⁴²⁾. The studies were all peer-reviewed, except for one master's thesis⁽⁴⁰⁾. The studies were most frequently cross sectional (n 9), with the exception of one

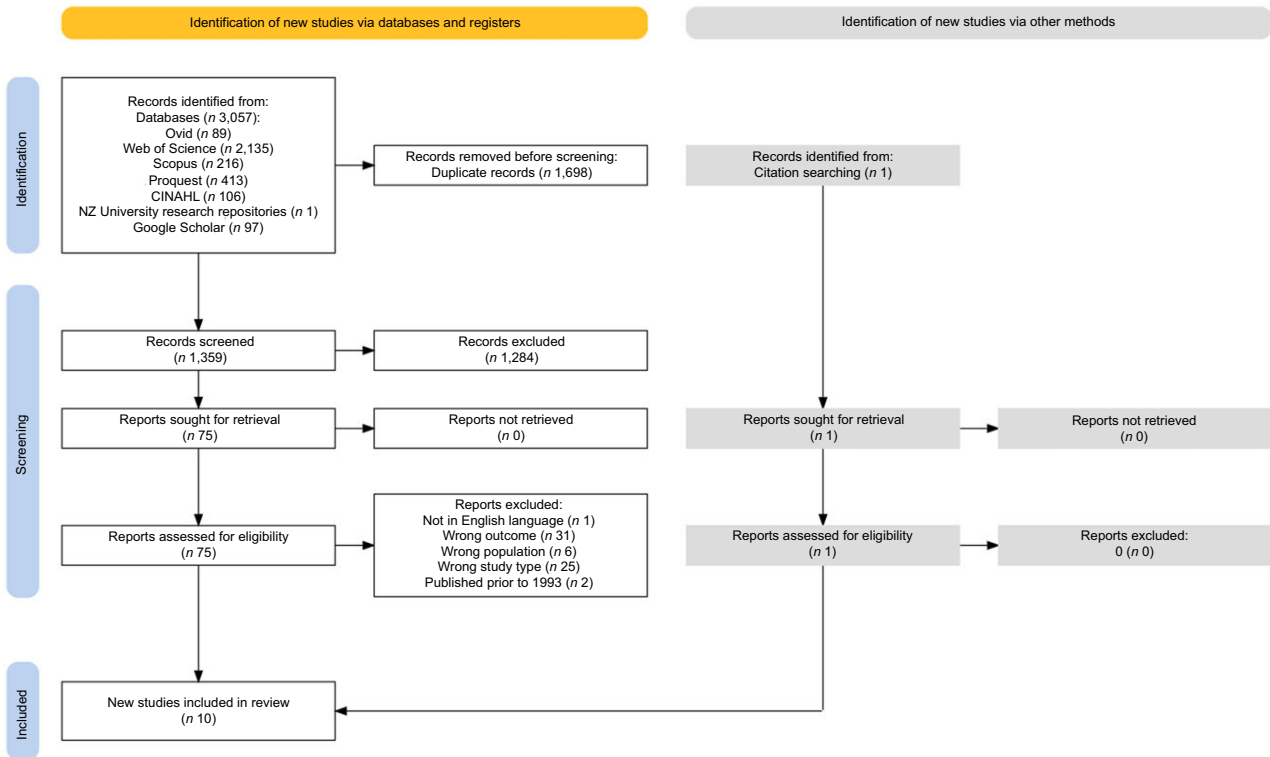


Fig. 1 Flow chart of included studies. Note. Source: ^(30,34).

intervention⁽³⁷⁾ conducted in Australia. Study characteristics are presented in Appendix B. Most studies were of high quality, and results of the critical appraisal are presented in Appendix C.

The studies assessed knowledge, attitudes or practices of health professionals with regard to: PBD in pregnancy (*n* 4)^(23,24,40,41), general nutrition in pregnancy with aspects of the research directly relevant to PBD (*n* 5)^(35–39) or PBD with aspects relevant to pregnancy (*n* 1)⁽³⁴⁾. Designs included quantitative (*n* 6), qualitative (*n* 1), mixed methods (*n* 2) or intervention (*n* 1). Most of the studies used a survey instrument developed or adapted for the study, for example, both Saintila and colleagues⁽⁴¹⁾ and Soh⁽⁴⁰⁾ adapted a survey instrument developed by Bettinelli and colleagues⁽²³⁾, employing similar question phrasing and assessment. The qualitative designs employed interviews conducted in-person^(36,38), via telephone⁽³⁸⁾ or video call⁽⁴⁰⁾, and the intervention study utilised a nutrition-education programme, evaluated using pre and post intervention surveys developed for the study⁽³⁷⁾.

A variety of health professionals were included in the study cohorts, including only midwives (*n* 3)^(36,38,39), health professionals working in clinical or community settings, including midwives, obstetricians, general practitioners, paediatricians, nurses, dietitians, nutritionists, health support workers and a paediatric registrar (*n* 5)^(23,24,35,40,43). One study included only dietitians⁽⁴¹⁾, and one study cohort consisted of a group of health professionals attending a plant-based nutrition conference⁽³⁴⁾. These participants

were predominantly medical doctors, although dietitians, nutritionists, nutritional scientists, alternative health professionals, pharmacists and other unspecified health professionals were included in the responses⁽³⁴⁾. Most participants engaged with patients at a primary or secondary level of healthcare, either in a hospital maternity unit, antenatal clinic, general practitioner clinic or independent practice. Sample sizes ranged from 7 to 475 participants. The studies' geographic location, participants' profession and dietary pattern, and main findings related to knowledge, attitudes, and practices are summarised in Table 3.

Knowledge of nutrition related to plant-based diets during pregnancy

Participants reported concerns about their lack of knowledge with regard to PBD, including a lack of confidence advising on, or discussing PBD in pregnancy^(36,39), and a limited ability to effectively advise individuals following PBD in pregnancy⁽²⁴⁾. Frequently reported sources of knowledge or information used by health professionals included: knowledge gained from education^(38,39), brochures, pamphlets and information sheets distributed by organisations or government publications^(38–40), scientific journals⁽⁴⁰⁾, nutrition organisations⁽³⁹⁾ and general knowledge⁽³⁹⁾.

Just over half of the studies (*n* 6) assessed knowledge of nutrients critical for maternal health and infant development^(23,35,37,39–41), with one study assessing this knowledge



Table 3 Relevant findings from the reviewed literature

Country, authors	Sample (n)	Participants' dietary pattern	Knowledge	Attitudes	Practices and knowledge sources
Italy, Bettinelli, M. E., Bezze, E., Morasca, L., Plevani, L., Sorrentino, G., Morniroli, D., Gianni, M. L., & Mosca, F. ⁽²³⁾	n 418 Nurses, midwives and health support workers.	342 (77.5 %) Omnivorous 73 (17.5 %) Semi vegetarian 21 (5 %) Vegetarian	55.7 % identified PBD mothers at greatest risk of vitamin B ₁₂ deficiency 14.1 % correctly identified n-3 PUFA are low or absent in PBD individuals 7.2 % identified Zn has greater bio-availability in an omnivorous diet 16.3 % identified plant proteins are less bioavailable than animal protein.	Significantly more vegetarians (90.5 %) believe planned vegetarian is appropriate for all life stages, compared with 45.2 % of semi vegetarians, 24.1 % of omnivores. Significantly more vegetarians (76.2 %) correctly answered a planned vegetarian diet does not increase negative outcomes compared with 35.6 % semi vegetarians and 30.6 % of omnivores.	Not reported
New Zealand, Elias, S., & Green, T. ⁽³⁹⁾	n 370 Midwives	Not reported	69.8 % moderately confident/confident advising vegetarian patients Most correctly answered questions regarding vegetarian iron sources, absorption enhancers and inhibitors (regardless of prior education) Just over half identified spirulina not a source for vitamin B ₁₂ and plant foods a poor source of Zn.	Not reported	Information sources referred to: nutrition organisations (86.5 %), general knowledge (83.2 %), general midwifery education (72.6 %) Resources most frequently used: Ministry of Health documents (e.g. Guidelines for Pregnant Women)
Germany, Jeitler, M., Storz, M. A., Steckhan, N., Matthiae, D., Dressler, J., Hanslian, E., Koppold, D. A., Kandil, F. I., Michalsen, A., & Kessler, C. S. ⁽³⁴⁾	n 475 Health professionals including students, doctors, nutritionists, and dietitians	275 (58 %) Vegan 77 (16 %) Vegetarian 119 (26 %) Omnivorous NS (< 1 %)	Knowledge of the German Nutrition Society, and US Academy of Nutrition and Dietetics' stance on vegan diets during pregnancy, lactation, childhood and German Nutrition Society stance on vegan diets in the general population. Answer either for or against. Median score 2.9 out of a possible 5	Association between personal dietary pattern and attitude towards vegan diet during pregnancy and lactation period, contingency coefficient (C* = 0.67, P < 0.001). Significant differences between groups (vegan, vegetarian and omnivorous). No effect of age or occupation on attitude regarding PBD in pregnancy	Not reported
Netherlands, Meulenbroeks, D., Versmissen, I., Prins, N., Jonkers, D., Gubbels, J., & Scheepers, H. ⁽²⁴⁾	n 121 (midwives) 179 (obstetricians) 111 (dietitians)	Not reported	66.1–68.6 % midwives and 75.4–93.9 % obstetricians report limited ability to advise PBD patients during pregnancy, education was insufficient. 82.9 % dietitians not educated on vegan diets in pregnancy, 13.5 % received education on vegetarian diets and pregnancy. 38.7 % reported sufficient knowledge to advise plant-based patients	77.7 % midwives, 74.3 % obstetricians identified themselves as responsible for providing pregnant PBD with advice and information. 80.2 % midwives 93.9 % obstetricians expect increased risk for developing deficiencies because of PBD. 87.6 % midwives 61.3 % obstetricians believe individuals following PBD require additional care	Midwives reported giving nutritional advice (30.5 %), referring to dietitian (24.8 %), checking blood Hb (iron deficiency) (24 %). Obstetricians reported checking general blood vitamin status (23.5 %), giving supplements (15.1 %), and referring to dietitian (14.5 %).
United Kingdom, Mulliner, C. M., Spiby, H., & Fraser, R. ⁽³⁶⁾	n 58 Registered midwives	Not reported	Concerns regarding level of knowledge when giving advice to vegetarian patients, almost half reporting this caused problems for them. Speculated patients' knowledge was more extensive than their own.	Not reported	Most had no protocol for patients following strict PBD. Most respondents said they would refer to a dietitian

Table 3 Continued

Country, authors	Sample (n)	Participants' dietary pattern	Knowledge	Attitudes	Practices and knowledge sources
Australia, Othman, S., Steen, M., Fleet, J.-A., & Jayasekara, R. ⁽³⁷⁾	n 19 Midwives	Not reported	<p>Vit C, D, B₁₂: Pre-intervention, 60.5 % identified as important micronutrients for PBD pregnancy, increased to 94.7 % post.</p> <p>n-3 PUFA: Pre-intervention, 25 % identified recommended sources, increased to 58.6 % immediately post-intervention, decreased to 36.8 % 6–8 weeks post.</p> <p>Protein: Response options majority animal sources. Pre-intervention 65.9 % identified sources. Minimal improvement post.</p> <p>Pre-intervention, 13.6–20.4 % moderately or very confident advising vegetarians, vegans. Increased to 63.1–42.1 % moderately or very confident post.</p>	Not reported	Not reported
Australia, Othman, S. M. E., Fleet, J.-A., Steen, M., & Jayasekara, R. ⁽³⁸⁾	n 7 Midwives	Not reported	<p>Increased confidence and knowledge after taking part in nutrition education workshop (reported elsewhere). Require more specialised information regarding PBD patients.</p>	Not reported	<p>Rely on personal experience/undergraduate education</p> <p>n 3 use resources on sources of iron for vegetarian individuals.</p> <p>Refer to a dietitian due to lack of knowledge.</p> <p>Not reported</p>
Peru, Saintila, J., Calizaya-Milla, Y. E., & Javier-Aliaga, D. J. ⁽⁴¹⁾	n 179 Dietitians	<p>72 (40 %) Vegetarian</p> <p>107 (60 %) Non-vegetarian</p>	<p>More than three quarters (both veg and non-veg) recognised plant-based proteins are less bioavailable than animal sources</p>	<p>Positive attitudes from both veg and non-veg dietitians. 84.7 % veg dietitians correctly answered that planned veg*n diets during pregnancy do not present higher risks of difficulties or birth defects, compared to non-vegetarian (62.6 %), and that a planned vegetarian diet is appropriate for all stages of life (91.1 % veg and 79.4 % non-vegetarian).</p>	Not reported
New Zealand, Soh, B. X. P. ⁽⁴⁰⁾	n 14 Health professionals including dietitian, nutritionist, medical doctor, nurse, paediatric registrar, midwives	<p>3 (21 %) PBD</p> <p>11 (79 %) Non-PBD</p>	<p>Most believed PBD increases Fe and B₁₂ deficiency. Half believed individuals following PBD increased risk of protein, n-3 PUFA and Ca deficiency.</p> <p>5/14 correctly identified B₁₂ not available from plant sources.</p> <p>Most identified PB sources of iron, and vitamin C increases Fe absorption.</p> <p>Most believed insufficient information for supporting patients following PBD, just over half felt confident advising these patients.</p>	<p>Most agreed well-planned vegan diet with B₁₂ supplementation suitable for pregnancy. Half unsure whether vegan diet during pregnancy promotes positive health outcomes.</p> <p>Most believed health-professionals responsible for providing information and supporting individuals following PBD</p> <p>Interviews: Respondents with firsthand experience of PBD more likely to have positive attitude.</p>	<p>Information sources referred to: Governmental publications, scientific journals, organisational handouts (i.e. from NZ Beef and Lamb). Difficulty referring to dietitian, despite mentioning need.</p> <p>Concern regarding lack of time and resources for discussing nutrition. Most respondents believed should take B12 and iron supplements.</p> <p>Most identified need for updated guidelines for PBD, particularly at different stages of life (pregnancy).</p> <p>Not reported</p>

Table 3 Continued

Country, authors	Sample (n)	Participants' dietary pattern	Knowledge	Attitudes	Practices and knowledge sources
France, Vilette, C., Vasseur, P., Lapidus, N., Debin, M., Hanslik, T., Blanchon, T., Steichen, O., & Rossignol, L. ⁽⁸⁵⁾	n 149 (general practitioners) 115 (paediatricians)	GP 6 (5%) Vegetarian 124 (95%) Non-vegetarian Pediatricians 1 (4%) Vegetarian 24 (96%) Non-vegetarian	81% felt ill-informed regarding PBD. 75% believe PBD at risk of iron deficiency. 50% believe vegetarians at risk of B ₁₂ and protein deficiency. More than two-thirds believe vegans are at risk of B ₁₂ and protein deficiency	51% of respondents believed LOV diet was unsuitable for pregnant and breast-feeding individuals. 91% believed vegan diet was unsuitable.	

PBD, plant-based diets; n-3 PUFA, long-chain polyunsaturated fatty acid; GP, general practitioner; LOV, lacto-ovo vegetarian.

following a nutrition education intervention⁽³⁷⁾. Four of these studies^(23,37,39,40) included questions to directly assess participants' knowledge of nutrition and PBD in pregnancy, for example, asking what nutrient a vegan mother is most at risk of being deficient in⁽²³⁾. Lastly, two studies^(35,41) reported on knowledge of nutrients relevant to PBD in pregnancy, although these questions were framed in a generalised manner, for example, asking about the bioavailability of plant-based protein⁽⁴¹⁾. An overview of the nutrients assessed and the question context is presented in Appendix D.

Micronutrients

Micronutrients frequently assessed included B vitamins (n 6)^(23,35,37,39-41), Fe (n 4)^(35,39-41) and Zn (n 5)^(23,35,39-41). Participants' self-reported lack of knowledge was frequently demonstrated through low scores on these knowledge assessments. While the majority of health professionals surveyed across studies identified the importance of these micronutrients, both in the general population^(35,41) and during pregnancy^(23,37,40), few health professionals were able to accurately identify dietary sources^(39,40). A notable exception to this is Fe. Knowledge of dietary sources of Fe was reasonably high among midwives and other antenatal carers surveyed in New Zealand, with more than two-thirds correctly identifying molasses⁽³⁹⁾ and legumes^(39,40) as dietary sources. However, by contrast, more than two-thirds also incorrectly identified spirulina as a good source of Fe⁽³⁹⁾. Surprisingly, these studies suggest most participants correctly identified vitamin C as an enhancer of and tannins as an inhibitor of Fe absorption^(39,40).

n-3 PUFA were briefly mentioned in five studies^(23,35,37,40,41), despite a growing body of evidence demonstrating their importance in fetal development⁽⁴⁴⁾. A similar pattern of knowledge was evident, with health professionals surveyed by Soh⁽⁴⁰⁾ recognising the importance of n-3 PUFA during pregnancy (for example, participants correctly stated pregnant individuals following vegan diets are more at risk of n-3 PUFA deficiency⁽⁴⁰⁾), yet lacked understanding of dietary sources⁽³⁷⁾, and the physiological implications of limited plant-based dietary intake^(23,41).

Vitamins A, C, D, Ca and iodine were assessed in four studies^(35,37,40,41), most frequently as part of a broad, multi-answer questions, such as listing supplements recommended for individuals following PBD in pregnancy (e.g.⁽⁴⁰⁾).

Macronutrients

Protein was the only macronutrient assessed in any of the included studies. Questions around protein included knowledge of dietary sources (n 1)⁽³⁷⁾, bioavailability (n 2)^(23,41), importance in PBD (n 1)⁽⁴¹⁾ and risks of deficiency (n 2)^(35,40). Knowledge of protein was moderate among midwives both before and after the nutrition

education intervention, with approximately two-thirds correctly identifying (predominantly animal-based) dietary sources of protein⁽³⁷⁾. Of the three studies investigating bioavailability, only one-fifth of antenatal-carers recognised the limited bioavailability of plant-based protein⁽²³⁾, compared with more than three quarters of dietitians⁽⁴¹⁾.

Attitudes and beliefs towards plant-based diets in pregnancy

Six studies assessed attitudes towards PBD in pregnancy. The studies employed various techniques, most frequently using Likert scales to elicit agreement or disagreement with statements or questions regarding beliefs or expectations. Positive attitudes were evident in three studies^(23,35,40), for example, most dietitians surveyed by Saintila⁽⁴¹⁾ agreed that a planned PBD is appropriate for all stages of life, regardless of their personal dietary preferences⁽⁴¹⁾. In one instance, the positive attitudes reported were tempered through follow-up questions; Soh⁽⁴⁰⁾ reports most health professionals agreed a B₋₁₂ supplemented, well-planned vegan was suitable for pregnancy, although half were unsure as to whether this could promote positive health outcomes⁽⁴⁰⁾. Almost two-thirds of dietitians believed planned PBD during pregnancy do not increase an individual's chance of experiencing a difficult pregnancy or birth defects⁽⁴¹⁾. Health professionals following PBD themselves were significantly more likely to agree PBD (vegan) are nutritionally adequate during pregnancy than health professionals following non-PBD⁽³⁴⁾.

However, negative attitudes towards PBD in pregnancy were also observed (n 3)^(23,24,35), expressed via poor expectations regarding pregnancy-related difficulties or birth defects (n 1)⁽²⁴⁾ or plant-based pregnancy outcomes (n 2)^(23,35). For example, most midwives and obstetricians surveyed by Meulenbroeks and colleagues⁽²⁴⁾ agreed with the statement 'Expect increased risk for developing deficiencies on a plant-based diet'⁽²⁴⁾. Similar findings were observed by Bettinelli and colleagues⁽²³⁾ and Villette and colleagues⁽³⁵⁾. A study investigating the beliefs and attitudes of general practitioners and paediatricians in France reported almost all participants believed a vegan diet was unsuitable for pregnancy or lactation⁽³⁵⁾. Beliefs regarding lacto-ovo vegetarian diets were more moderate – approximately half believed a lacto-ovo vegetarian diet was unsuitable⁽³⁵⁾.

Midwives, obstetricians and other health professionals surveyed appear to take professional responsibility for advising pregnant individuals on nutrition⁽³⁹⁾ and those following PBD^(24,40), despite the admission that their knowledge is not sufficient. In addition to this, most midwives and nearly two-thirds of obstetricians surveyed believed these individuals require extra care during their pregnancy⁽²⁴⁾.

Practices

Four studies reported on the practices of health professionals with regard to PBD in pregnancy^(24,36,38,40). Less than 3 % of midwives and obstetricians reported having a practice protocol for managing PBD in pregnancy⁽²⁴⁾. Frequently mentioned practices included referrals to dietitians^(24,36,38,40), giving nutritional advice and ordering blood tests to assess vitamin status⁽²⁴⁾ and distributing pamphlets or other 'information sheets'⁽³⁸⁾. In contrast to the midwives surveyed by Meulenbroeks and colleagues⁽²⁴⁾, obstetricians surveyed in the same study most frequently reported performing blood tests to analyse vitamin status, followed by prescribing supplements, and referring to a dietitian⁽²⁴⁾. A number of barriers were noted toward implementing these practices: referrals were limited by difficulty in accessing dietitian services⁽⁴⁰⁾, and provision of resources appeared to be dependent on the availability at the clinic, and are predominantly aimed at general nutrition and food safety in pregnancy⁽³⁸⁾, for example, minimising exposure to toxoplasmosis.

Dietary guidelines

Of the reviewed studies, only five commented on health professional knowledge of established dietary guidelines regarding PBD during pregnancy, with only one study specifically including this aspect in their research scope⁽³⁴⁾. Health professionals surveyed by Jeitler and colleagues⁽³⁴⁾ demonstrated moderate knowledge of the German and American nutrition societies' position statements regarding the suitability of PBD during pregnancy, with respondents following vegan diets scoring significantly higher compared with those following vegetarian or omnivorous diets. The qualitative interviews conducted by Soh⁽⁴⁰⁾ revealed both a perceived lack of relevant information in the New Zealand dietary guidelines, and the importance of having more detailed, evidence-based guidelines for health professionals to reference.

The remaining three studies referenced a wide variety of guidelines during survey development^(23,37) or modification⁽⁴¹⁾, including both country-specific^(23,37) and international⁽⁴¹⁾. Only Othman and colleagues⁽³⁷⁾ directly questioned knowledge of these guidelines in questions unrelated to PBD. The survey developed by Bettinelli and colleagues⁽²³⁾ and later modified by Saintila and colleagues⁽⁴¹⁾, contained a knowledge question regarding the appropriateness of PBD during pregnancy and appeared to be based on the often-cited American Dietetic Association guidance, stating a well-planned PBD was appropriate for pregnancy⁽⁴⁵⁾.

Influences on knowledge and attitudes towards plant-based diets

Health professionals' knowledge, attitudes and practices appeared to be moderated by their professional



specialisation. For example, dietitians scored consistently higher when answering nutrition knowledge questions⁽⁴¹⁾, compared with other health professionals such as nurses and midwives⁽²³⁾. In addition, more dietitians reported having sufficient knowledge to advise pregnant individuals following PBD (39 %), compared with midwives (24 %) and obstetricians (7 %), though the overall proportion reporting sufficient knowledge remains low⁽²⁴⁾.

Attitudes of dietitians were frequently positive towards PBD in pregnancy, with more than two-thirds disagreeing with a statement claiming PBD in pregnancy increase an individuals' risk of pregnancy complications and birth defects⁽⁴¹⁾, compared with one-third of other health professionals (nurses, midwives and health care support workers)⁽²³⁾.

Half of the studies reported participants' own dietary patterns ($n = 5$)^(23,34,35,40,41). PBD were followed by between 5 and 22.5 % of participants^(23,35,40). One study specifically recruited vegetarian participants, thus 40 % of their cohort reported following vegetarian diets⁽⁴¹⁾. Lastly, one study took place at plant-based nutrition conference, where 74 % of participants reported following plant-based dietary patterns⁽³⁴⁾. Participants' own dietary patterns appear to influence their knowledge, attitudes and practices with regard to PBD in pregnancy. This is particularly apparent in Bettinelli and colleagues⁽²³⁾ study, where significantly more vegetarian health professionals correctly answered questions regarding the appropriateness of a planned PBD during different life stages including pregnancy, lactation and infancy⁽²³⁾. Similar quantitative results were observed among dietitians⁽⁴¹⁾ and other health professionals⁽³⁴⁾. This was further demonstrated through interviews with various health professionals, who revealed attitudes towards individuals following PBD in pregnancy, were more positive if they had personal experience of them⁽⁴⁰⁾.

Discussion

Poor-to-moderate knowledge of plant-based nutrition in pregnancy

In line with recent global interest in plant-based eating⁽³⁾, PBD in public health⁽⁴⁾ and sustainable nutrition⁽⁵⁾, there is a growing interest in PBD from the scientific community. It is apparent from the lack of knowledge both demonstrated and self-reported by the health professionals that this increased understanding at an academic level is yet to be reflected in evidence-based practice. Most publications reviewed were published in the last 5 years, yet compared with the two earliest publications^(36,39), the challenge of a lack of knowledge or confidence with regard to PBD in pregnancy appears unchanged^(24,35,37).

Despite general awareness of micronutrients relevant to PBD in pregnancy, there appears to be limited understanding regarding how these micronutrients fit into a dietary context. An interesting exception to this is Fe – two

studies revealed an understanding of absorption enhancers and inhibitors, a relatively advanced nutrition concept^(39,40). Both studies also revealed the health professionals referenced a variety of sources for nutrition information. These include reliable, evidence-based sources such as nutrition organisations, scientific journals and governmental publications, to publications from industry organisations with commercial interests, such as Beef + Lamb New Zealand Incorporated (Beef + Lamb NZ), funded by farmers, retailers and meat processors, with the purpose of promoting the New Zealand beef and lamb industry. The use of potentially biased, industry-sourced material in a health care setting is surprising. However, we speculate the consumer-friendly publications and marketing campaigns promoting Fe from organisations such as Beef + Lamb NZ, in addition to detailed dietary guidelines published by the New Zealand government (e.g. Eating and Activity Guidelines⁽⁴⁶⁾) may increase familiarity of Fe, including knowledge of various dietary sources, and foods that can promote or inhibit absorption. In addition, Fe intake is recognised as a common concern during pregnancy, and Fe deficiency or anaemia can occur as a result of poor dietary intake⁽⁴⁷⁾, or increased blood volume resulting in haemodilution⁽⁴⁸⁾. As such, Fe status is regularly tested during pregnancy, and despite reported practice inconsistencies⁽⁴⁹⁾, this would ultimately contribute to a heightened awareness.

The health professionals surveyed in the reviewed studies frequently attributed their own lack of knowledge to a lack of training and education in plant-based nutrition. Of the studies' participants, dietitians are the most specialised regarding nutrition and dietary advice, yet their training regarding plant-based diets in pregnancy is reportedly infrequent⁽²⁴⁾. It is likely due to specialised knowledge of relevant micro- and macro-nutrients, and general pregnancy dietary requirements that dietitians report higher levels of confidence when advising pregnant individuals following PBD, compared with other health professionals⁽²⁴⁾.

In practice, it is often midwives and other antenatal care providers, not dietitians, who are responsible for giving dietary advice during pregnancy. This is a view held by pregnant individuals⁽¹⁹⁾, other health professionals⁽²⁴⁾ and midwives themselves^(24,50). Despite this responsibility, midwives surveyed report their nutrition education regarding PBD and pregnancy as being insufficient⁽²⁴⁾. This is particularly concerning, considering midwives frequently rely on their undergraduate education for their nutrition knowledge^(38,39,51). This misalignment between the apparent role of midwives in providing advice, and the training, resources and support provided must be addressed, and the curricula adapted to reflect global changes in diet.

Othman and colleagues⁽³⁷⁾ demonstrated the effective use of a nutrition education intervention for midwives, resulting in a significant improvement in pregnancy nutrition knowledge (including aspects related to PBD).



While follow-up studies within this demographic are scarce, evidence suggests continuing professional development could be used as an effective tool to upskill this group⁽³⁷⁾.

Participant factors influencing attitudes, knowledge and practices

Attitudes towards PBD in pregnancy range from positive to negative, appear to be associated with personal dietary patterns, and professional specialisation. Attitude formation is influenced by a range affective (emotional) and cognitive (knowledge-based) factors⁽⁵²⁾. This model can be used to shed light on the role of personal dietary patterns and professional specialisation regarding PBD in pregnancy.

Professional specialisation

When reported, health professionals with nutrition-focused specialisations, such as dietitians, appeared to view PBD in pregnancy more favourably⁽⁴¹⁾, in addition to demonstrating an increased level of knowledge compared with other health professionals surveyed. We hypothesise the knowledge and confidence acquired during training or professional development⁽³⁷⁾ contributes to the positive attitudes displayed by this cohort⁽⁵²⁾. One study did not find a significant association between professional specialisation and attitude⁽³⁴⁾; however, the cohort was a convenience sample of health professionals attending a plant-based nutrition conference, of which the majority followed PBD. Thus, we would expect this cohort to have positive attitudes towards PBD regardless of their specialisation.

Personal dietary patterns

Previous research has demonstrated individuals display positive attitudes towards their own dietary pattern and negative attitudes or beliefs regarding other diets⁽⁵³⁾, consistent with findings of the reviewed studies. Of the studies that investigated health professionals' own dietary preferences, most reported participants following PBD were more likely to have a positive attitude towards their patients following PBD in pregnancy^(23,34,41). Soh's⁽⁴⁰⁾ qualitative interviews support these findings, and the remaining study⁽³⁵⁾ did not report relevant analysis. We hypothesise personal dietary patterns influence health professionals' attitudes in two ways; cognitively, by increasing their knowledge, understanding and awareness of PBD and affectively, through the recognition or affirmation of their own dietary choices⁽⁵³⁾. The chances of encountering a health professional following a PBD is low, yet for individuals following PBD, their quality of care could be significantly influenced by this.

Research gap in health professionals' practices regarding plant-based diets in pregnancy

There is limited evidence regarding practices of health professionals when caring for pregnant individuals

following PBD. In the current review, the four studies that reported on professional practices all included midwives^(24,36,38,40), one group of obstetricians⁽²⁴⁾ and a small number of other antenatal care providers⁽⁴⁰⁾. Few health professionals reported having a practice protocol to treat pregnant individuals following PBD⁽²⁴⁾. Given the demonstrated lack of knowledge and confidence with regard to PBD in pregnancy, a protocol could promote better care among these groups. Although referrals to dietitians were frequently mentioned, it is unclear how effective this is in practice – dietitians report moderate knowledge on PBD in pregnancy⁽²⁴⁾ and reported difficulties accessing their services⁽⁴⁰⁾. While the majority of Soh's (2022) cohort believed individuals following PBD in pregnancy should take Fe and Vitamin B₁₂ supplements, it is unclear whether this is followed through in practice⁽⁴⁰⁾.

Dietary guidelines

While a few studies commented on the appropriateness of well-planned PBD for pregnancy in line with the American Dietetic Association position statement⁽⁴⁵⁾, there appears to be limited research with a specific focus on how health professionals incorporate national dietary guidelines regarding PBD into their practice. The omission of country specific dietary guidelines from these investigations may be due to their lack of detailed, relevant information, e.g. Peru⁽⁵⁴⁾, or in some instances, discouragement of PBD during pregnancy, e.g. Germany and Italy^(55,56). As a result, a number of the surveys referenced guidelines from countries different to the study population^(23,41). Although dietary guidelines are evidence-based and created following rigorous methodology⁽⁵⁷⁾, they are country-specific, and designed to cover a range of groups within the national population. For example, New Zealand and Australia share a food standards regulatory body, yet develop different dietary guidelines culturally appropriate for their populations⁽⁵⁸⁾.

Results from the studies conducted in Germany and Italy^(23,34), indicating the majority of health professionals following PBD agree they are suitable for pregnancy, are somewhat incongruous with the German and Italian dietary guidelines. While this may be demonstrative of health professionals' subjective experience positively influencing their attitudes towards PBD in pregnancy⁽³⁴⁾, it also suggests the level of knowledge required by these health professionals would go beyond that contained in the dietary guidelines. This is not unreasonable for nutritionists or dietitians, but for midwives or health professionals responsible for numerous aspects of maternal care, having this specialist knowledge is likely unfeasible.

Strengths and limitations

Although few studies were eligible for review, the geographic spread of the literature enabled a diverse range of evidence to be summarised and reviewed. Despite this,



almost all the studies reviewed were observational and identified numerous research gaps. Unfortunately, only one study used an education intervention designed to address some of these knowledge gaps⁽³⁷⁾. While the intervention demonstrated an overall improvement in health professional knowledge, the study was limited by a small sample size, high attrition rate and a limited range of questions used to assess changes in nutrition knowledge⁽³⁷⁾.

The current review used a systematic approach to perform a scoping review, allowing for inclusion of evidence from a wide range of sources. Despite the rigorous approach, some limitations must be noted. Restricting results by language may have led to the omission of some non-English, non-Western literature.

Although the studies included are from a diverse range of geographic locations, they are all upper-middle- (Peru) and high income, with established health-care systems that require extensive education and training to work as health professionals. In some instances, this may limit the relevance of these results to developing nations, whose populations are more at risk of undernutrition (e.g. increased prevalence of Fe deficiency anaemia⁽⁵⁹⁾), and experience limited access to high-quality antenatal care⁽⁶⁰⁾.

Implications

There is a growing movement to implement better nutrition education for health professionals, yet even health professionals with nutrition specialisations feel ill-prepared to counsel pregnant individuals following PBD. There is a clear need for specific curriculum regarding PBD during pregnancy, tailored to the health professionals frequently involved in antenatal care, such as midwives, obstetricians and family doctors. It is apparent researchers must encourage the translation of the growing body of evidence regarding PBD into clinical practice and the public health sphere, along with conducting further research utilising intervention study designs. More broadly, the increasing interest in PBD among women of reproductive age demands greater understanding of clinical outcomes, such as perinatal depression, macronutrient intake and corresponding gestational weight changes. For the increasing number of individuals following PBD during pregnancy, the difference between optimal or sub-optimal care with regard to dietary advice may be determined by geographic location and the knowledge and attitudes of the health professionals encountered.

Conclusion

This scoping review investigated the knowledge, attitudes and practices of health professionals, with regard to plant-based diets in pregnancy. Ten articles were eligible for review, revealing a sparse body of literature. Three main

findings were identified: (1) Health professionals' knowledge of plant-based nutrition in pregnancy is limited, this is frequently attributed to a lack of nutrition education; (2) Health professionals' own dietary patterns and their professional specialisation are associated with their knowledge, attitudes and practices and (3) there is a significant research gap regarding health professionals' practices with regard to PBD in pregnancy. Further avenues of research include studies investigating the knowledge, attitudes and practices of health professionals from specialisations such as general practice; studies to determine the impact of knowledge of and attitudes towards PBD on the practices of health professionals and a continuation of the standardised survey that is beginning to be implemented in this field of research to enable a systematic review and meta-analysis of the evidence.

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Conflicts of interest

There are no conflicts of interest.

Authorship

Stephanie C. McLeod: Conceptualization, Investigation, Methodology, Project administration, Data curation, Writing – original draft. Jessica C. McCormack: Conceptualization, Investigation, Methodology, Writing – review & editing. Indrawati Oey: Funding acquisition, Writing – review & editing. Tamlin S. Conner: Methodology, Writing – review & editing. Mei Peng: Conceptualization, Funding acquisition, Methodology, Resources, Supervision, Writing – review & editing.

Ethics of human subject participation

Not applicable.

Supplementary material

For supplementary material accompanying this paper visit <https://doi.org/10.1017/S1368980024001484>



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