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Folic acid and iodine supplement use: a
cross-sectional survey from preconception
through to six weeks post-partum in New
Zealand women

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requirements for the degree of

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Brianna Rose Hunter

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Abstract

Background: Folic acid (FA) (0.8 mg and 5 mg for high-risk individuals) and iodine (150µg) supplements are recommended by the Ministry of Health (MOH) for pregnant and/or lactating women in New Zealand (NZ). Evidence suggests that many NZ women are not only taking FA and iodine in the form of a single nutrient supplement but are taking FA and iodine as part of a multivitamin (MVT) supplement which may or may not contain the recommended doses, and some are using a combination of both. No NZ study has examined the daily dose taken from both single nutrient supplements and MVT for both FA and iodine across all time periods.

Aim: The aim of this study was to investigate what nutritional supplements containing FA and iodine were taken by postpartum NZ women, preconception, during the three trimesters of pregnancy and post-partum, and examine how well the women's supplement use aligned with the NZ MOH recommendations.

Methods: This cross-sectional observational study utilised data gathered on FA and iodine supplement use from an anonymous survey between February and August 2022. Descriptive statistics including frequency and percentages were reported. Folic acid and iodine weekly intakes from single nutrient supplements and MVT were calculated by multiplying the amount of nutrient in each supplement, with the number of times per day taken, and the average number of days taken per week reported. Binary logistic regression was used to identify the associations between the levels of FA and iodine supplement usage and selected sociodemographic characteristics.

Results: A total of 584 women were included in the analysis. In addition to the single nutrient supplements for FA (0.8 mg and 5 mg) and iodine (150 µg), women took 28 different MVT. Fifty-eight percent (preconception; 30% from single nutrient supplements, 18% from MVT and 10% from both) and 96% (first trimester pregnancy; 61% from single nutrient supplements, 17% from MVT, and 19% from both) of women took FA-containing supplements. More than 75% of women reported taking iodine-containing supplements during pregnancy (first and second trimesters: 93%, third

trimester: 89%) and postpartum (76%). Approximately 60% took single nutrient supplements, 18% took only MVT and 14% took both. Based on the MOH recommendations, only 30% (preconception) and 62% (first trimester) achieved sufficiency of FA supplementation at 0.8 mg/day; 35% (preconception) and 69% (first trimester) achieved sufficiency of FA at 5 mg/day; around 50% women achieved sufficiency of iodine supplementation at 150 µg/day during pregnancy while only 37% during postpartum. The balance either took none, an insufficient dose or a dose that exceeded the recommended dose and many took them during non-recommended periods (FA after the first trimester; iodine preconception). Taking none or insufficient amounts of these nutrients was mostly associated with women who had been pregnant previously or had never used supplements before pregnancy.

Conclusion: Most women reported taking FA and/or iodine-containing supplements at some point before, during and after their pregnancy. However, it is concerning that a large number of women do not seem to be taking them in accordance with the MOH recommendations in terms of both the dose and/or recommended time periods.

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List of Abbreviations and Symbols

| Abbreviation or Symbol | Definition |
|------------------------|---|
| BMIC | Breastmilk Iodine Concentration |
| et al. | And others |
| EAR | Estimated Average Requirement |
| FA | Folic Acid |
| GP | General Practitioner |
| GUiNZ | Growing up in New Zealand study |
| LMC | Lead Maternity Carer |
| mg | Milligram |
| µg | Microgram |
| MINI | Mother and Infant Nutrition Investigation study |
| mL | Millilitres |
| MOH | Ministry of Health |
| NZ | New Zealand |
| RCT | Randomised Control Trial |
| SCOPE | Screening for Pregnancy Endpoints study |
| TSH | Thyroid Stimulating Hormone |
| T ₃ | Triiodothyronine |
| T ₄ | Thyroxine |
| UIC | Urinary Iodine Concentration |
| WHO | World Health Organization |
| % | Percentage |
| ≥ | Equal to or greater than |
| ≤ | Equal to or less than |
| ± | Plus-minus |

Chapter 1: Introduction

1.1. Background

Due to physiological changes that occur during pregnancy and lactation, a woman's nutritional requirements during this time differ significantly to those of their non-pregnant counterparts (Jouanne et al., 2021; Ministry of Health, 2006; Picciano, 2003; World Health Organization, 2016). The requirements of growing a foetus, as well as the maternal adaptations that occur to support a pregnancy result in increased requirements for a range of nutrients including folic acid (FA), iodine, iron and vitamin D (Jouanne et al., 2021; Picciano, 2003). It is important these requirements are met for the health of the mother and foetus, as evidence suggests that an inadequate intake of key nutrients may lead to poor pregnancy outcomes including developmental delays, birth defects, and birth complications (Christesen et al., 2012; Czeizel & Dudás, 1992; Medical Research Council, 1991; Molloy et al., 2008; Pludowski et al., 2013; Skeaff, 2011; Velasco et al., 2018; Wagner et al., 2008).

Although a varied diet that provides an adequate intake of most nutrients can support a healthy pregnancy, it is increasingly recognised that for some women it is not possible to achieve the increased requirements and maintain an adequate status for some nutrients such as FA, iodine, and iron from food alone or in the case of vitamin D, from food and/or sun exposure.

In recognition of the importance of achieving an adequate status for certain nutrients, the World Health Organization (WHO) has developed guidelines recognising the role of nutritional supplementation to support a healthy pregnancy. These include the safe and effective use of supplements such as FA during this time (World Health Organization, 2016). Based on the WHO guidelines and factors specific to New Zealand (NZ), for example, that NZ soils are low in iodine and that there is evidence which suggests pregnant woman's iodine status may not be sufficient (Jin et al., 2021), the NZ Ministry of Health (MOH) has implemented its own recommendations, as well as other public health measures to increase the nutritional status of women of childbearing age. The

recommendations include supplementation of FA and iodine, as well as an accompanying statement on vitamin D supplementation for those at high risk of deficiency (Ministry of Health, 2018). The effectiveness of supplementation, however, relies on the awareness of the recommendation (by both parents and health professionals), being able to purchase or have the supplements prescribed and whether women take the supplements as recommended. Food fortification for FA and iodine have also been implemented to improve the status of these nutrients within the population (Ministry for Primary Industries, 2012; Ministry for Primary Industries, 2021; Ministry for Primary Industries, 2022).

For FA and iodine, the NZ MOH has the following specific recommendations for supplement use during specific time periods. A dose of 0.8 mg FA should be taken daily for one month before pregnancy through to 12 weeks after becoming pregnant and 150 µg iodine should be taken daily when pregnant and while breastfeeding (Ministry of Health, 2020; Ministry of Health 2021). A higher dose of FA (5 mg daily) is recommended for women who are affected by a neural tube defect (NTD) themselves, who have a child with a NTD, close family member or family history of NTD as well as those taking certain medications (Ministry of Health 2021). For both nutrients, if they are prescribed, there are subsidised single nutrient supplements available. However, there is evidence that some NZ women are choosing to take a multivitamin (MVT) or a combination of a MVT with separate FA and iodine single nutrient supplements (Brown et al., 2020; Bulloch et al., 2019; Jin et al., 2021; Teixeira et al., 2018). These studies have also identified that there are a range of pregnancy MVT available in NZ, which in the case of FA and iodine recommend varied daily doses (amount of FA or iodine per single dose x recommended dosing frequency).

There have been a number of studies that have tried to determine how well the recommendations for FA and/or iodine supplementation have been adhered to (Brough et al., 2015; Bulloch et al., 2019; Jin et al., 2021; Mallard & Houghton, 2012; Reynolds & Skeaff, 2018; Teixeira et al., 2018). However, this area is complex to research and there are still gaps in the literature. Few studies have captured the total daily dose taken of both FA and iodine (from both single nutrient and MVT sources) by women. Additionally,

few researchers have attempted to explore supplement use during all five timeframes (pre-pregnancy, trimester one, trimester two, trimester three and post-partum).

Folic acid supplement use around pregnancy has been identified as being associated with age, education, socio-economic status, and whether or not the pregnancy was planned in NZ (Bulloch et al., 2019; Dobson et al., 2006; Morton et al., 2013; Teixeira et al., 2018). Australian researchers have reported that age, maternal income, and first-time pregnancy (Hine et al., 2018), and planned pregnancy (Malek et al., 2016) were associated with the use of iodine supplements during pregnancy. In NZ, pregnant women with low education and income were less likely to use iodine supplements (Mallard & Houghton, 2014), and only one study reported iodine knowledge predicted the use of iodine supplements by breastfeeding women, but educational attainment and household income were not predictors (Jin et al., 2021). However, there is limited research to identify factors associated with iodine supplement use by pregnant and lactating women in NZ.

1.2. Purpose of this study

Although there is some evidence on women's FA and iodine supplement use around pregnancy in NZ, there is limited data about what specific products are being used, what daily doses are being taken and whether what they are taking aligns with the NZ MOH recommendations. This research will provide an updated insight into what FA or iodine-containing nutritional supplements women are taking before, during and after their pregnancy, and whether the doses and time periods they are taking them for align with the current NZ MOH recommendations. It was important to capture all of these stages around pregnancy due to the specificity of timing of supplement use in the recommendations for these different stages. Collecting this data allows us to identify trends overtime as well as identify potential areas for further research. Additionally, we aim to examine whether the pregnancy MVT that are available in NZ provide an adequate daily dose of FA and iodine. If more women are choosing to take a MVT then it is important they and their LMC are aware of which ones provide the correct daily dose to meet the current NZ MOH recommendations for FA and iodine.

1.3. Aim

This study aims to use an online questionnaire to investigate what nutritional supplements containing FA and iodine and dosage of each were taken by postpartum NZ women, preconception, during the three trimesters of pregnancy and post-partum.

1.3.1. Objectives

1. To identify multivitamin supplements that contain FA and iodine that are marketed towards pregnant and breastfeeding women in NZ and assess if the recommended daily doses of these supplements align with the MOH recommendations.
2. To determine what nutritional supplements that contain FA and/or iodine are being taken by NZ women before, during the different stages of their pregnancy and women post-partum period (first six weeks following childbirth).
3. To examine if NZ women's supplement use is aligned with the NZ MOH recommendations.
4. To explore sociodemographic and lifestyle determinants of sufficient FA and/or iodine supplement intake in NZ women.

1.4. Thesis structure

This thesis is divided into four chapters. Chapter one is an introduction to the background, purpose, aims, and objectives, of the study. Chapter two is a narrative review of the current literature on supplement recommendations around pregnancy, existing evidence of supplement intake, and supplement knowledge. Chapter three is presented as a manuscript for publication and includes the abstract, introduction, methods, results, discussion, and references to relevant appendices. Chapter four explores conclusions and recommendations based on the study findings. The appendices include supplementary results, recruitment resources, and the questionnaire.

1.5. Researcher contributions

Table 1. Researchers' contributions to this study.

| Author | Contribution to thesis |
|---|--|
| Brianna Hunter MSc Nutrition and Dietetic candidate | Primary author of this thesis and responsible for all study components including leading the research, completing the ethics application, part of the team who designed the questionnaire for the study, literature review, recruitment, data collection and analysis, interpretation of results, and finalising and submission of thesis chapters and manuscript. |
| Dr Cheryl Gammon Academic Supervisor | Academic supervisor supported ethics application developed study concept and design, and part of the team who designed and reviewed the questionnaire for the study. Assisted with recruitment and supported data analysis. Assisted in result dissemination. Revised and approved the thesis chapters and manuscript. |
| Dr Ying Jin Academic Supervisor | Co-supervisor, supported ethics application, developed study concept and design, and part of the team who designed and reviewed the questionnaire for the study. Assisted with recruitment and supported data analysis. Assisted in result dissemination. Revised and approved the thesis chapters and manuscript. |
| Hajar Mazahery Postdoctoral research fellow | Advised on data analysis |

Chapter 2: Literature review

2.1. Introduction

The nutritional requirements during pregnancy and while lactating differ to those of non-pregnant women due to maternal physiological changes and the increased needs of perinatal growth and development.

Moreover, the energy requirements of growing a foetus as well as metabolic changes that occur while pregnant, result in increased energy needs throughout the different stages of pregnancy. No additional energy is required in the first trimester however, an additional 335 kcal and 454 kcal per day is required in the second and third trimesters, respectively (National Health and Medical Research Council, Australian Government Department of Health and Ageing, New Zealand Ministry of Health [NHMRC, AGDHA, NZMOH], 2019).

Hormonal changes that occur throughout pregnancy cause changes to many physiological functions including a rise in cellular and metabolic activity, increased production of haemoglobin and shifts in thyroid and calcium homeostasis. These changes increase the requirements of particular micronutrients such as iron, folate, iodine and vitamin D (Jouanne et al., 2021; Picciano, 2003). It is important that the mother's intake of these nutrients during this time reflects the increased requirements to ensure optimal development of the foetus.

Once the baby is born, a mother's energy requirements remain high if she is lactating due to the increased energy required to produce breast milk. An additional 478-502 kcal per day is required by women who are exclusively breastfeeding for the first six months and partially breastfeeding thereafter (NHMRC, AGDHA, NZMOH, 2019). For exclusively breastfed infants, breastmilk is their sole form of nutrition for the first four to six months of their life. Therefore, it is important that the breastmilk is nutritionally complete to support the continual growth and development of the baby over this period.

As a woman's diet is not always able to meet the increased requirements of certain nutrients, supplements are recommended to increase the intake where an increased intake has been identified as being beneficial such as folic acid (FA) or where there is concern about there being an adequate intake or achieving an adequate status, such as iodine.

This chapter reviews the current literature on New Zealand (NZ) women's use of supplements before, during and after pregnancy, with a specific focus on FA and iodine that are recommended to be taken by all women at certain time periods. Web of Science, PubMed, Scopus, Google Scholar and Massey University's Discovery search engine were used to obtain literature. In addition, the NZ Ministry of Health (MOH) website was used to source the current recommendations, and supporting evidence behind them. Birth data from Statistics NZ was also used to identify statistical trends within the NZ population. The search period ranged from November 2021 to April 2023, where multiple search terms were used, including:

- Pregnancy OR pregnant OR prenatal OR antenatal OR perinatal OR maternal OR breastfeeding OR lactating OR lactation
- Supplementation OR supplements OR supplement OR vitamins OR vitamin OR multivitamin OR nutrition OR nutrients OR nutrient OR diet
- Folic acid OR folate OR iodine OR guidelines OR guideline OR recommendations OR recommendation OR recommended
- New Zealand OR NZ OR Aotearoa
- Survey OR surveys OR questionnaire OR questionnaires

2.2. Supplement use during pregnancy and breastfeeding.

Supplements taken during pregnancy and breastfeeding can be grouped into two categories. Supplements that are recommended to women to increase dietary intake as research has identified a need and/or that it is beneficial. This group includes FA and iodine. In NZ for the MOH has specific recommendations for these. The second group includes micronutrients such as iron, vitamin D and vitamin B12, where there is concern about individual women achieving adequate levels.

2.2.1. Folate/Folic acid

Folate (or vitamin B9) is the form of this nutrient found naturally in foods whereas FA is the synthetic form of folate and is the form found in supplements. The synthetic form is more stable and bioavailable and converts to folate in the body (Ministry of Health, 2022).

Folate is an essential cofactor for the enzymes involved in one-carbon metabolism which is responsible for the biosynthesis of nucleic acids necessary for DNA and RNA synthesis (Tamura & Picciano, 2006). Both of which are essential for the growth and development of a foetus, which in turn results in an increased demand for folate during pregnancy (Molloy et al., 2008). A deficiency of folate is associated with foetal congenital abnormalities, but may also lead to megaloblastic anaemia in the mother (Ministry of Health, 2022)

In the 1960's, it was first noticed that women who had given birth to children with serious birth defects such as neural tube defects (NTD), were likely to have impaired folate status compared to those with unaffected children (Wald, 2011). This led to a multi-centre intervention study of women who had previously given birth to a child with an NTD. Women were given a multivitamin (MVT) preparation which contained 0.36mg of FA. The researchers found a significant relationship between periconceptual vitamin supplementation and a reduced risk of NTD recurrence in the supplemented group compared to the control group (women who were already pregnant and who had not taken the vitamin supplementation) (Smithells et al., 1980).

This was followed by a randomised controlled double-blind study of 111 women, who had also previously given birth to a child affected by a NTD. Women received either 4mg FA or a placebo treatment daily which they were asked to take until conception and during early pregnancy. A significant difference in birth outcome between the supplement group and the placebo group was reported, with no recurrences of NTD seen in the FA group (Laurence et al., 1981).

At around the same time another trial (n=4704) was conducted to study whether periconceptional MVT supplementation reduced the risk of a first occurrence of NTD (Czeizel & Dudás, 1992). Women either received Elevit Pronatal (containing 0.8 mg FA, 4 minerals and 3 trace elements) or a trace-element supplement for at least one month prior to conception up until their second missed menstrual period. The findings from this study indicated that the use of a preconceptional MVT containing FA decreased the risk of NTD first occurrences with no cases seen in the group supplementing with the Elevit Pronatal compared to six cases of NTD among the trace-element supplement group (Czeizel & Dudás, 1992). However, it is important to note that as the Czeizel & Dudás' study also included other vitamins and minerals in their supplement, they could not conclude that the reduced incidence of NTDs was due to FA alone.

These studies prompted the Medical Research Council to conduct an international, randomised controlled trial (RCT) in seven countries (UK, Hungary, Israel, Australia, Canada, USSR Moscow and France) to study whether a FA-only supplement or a MVT supplement (not containing FA) could prevent NTD recurrence (Medical Research Council, 1991). This study of 1195 women who had experienced a previous pregnancy that had been affected by a NTD were divided into four groups (4 mg FA, MVT with no FA, 4 mg FA and MVT or nothing). No significant effect was seen in the group of women who took the MVT with no FA. Yet, the two groups that took a 4 mg dose of FA taken from the date of randomisation up until the end of the first trimester reduced the risk of a NTD by 72% compared to the groups that did not take the FA supplement (Medical Research Council, 1991).

Following this, a case-control study was conducted by Werler et al. (1993) in the United States and examined whether periconceptional FA intake reduced the risk of first occurrence NTDs. Both exposure (length and frequency of use) and dose of FA was studied in 3051 mothers. This study was the first to report a statistically significant reduction of approximately 60% in NTD risk at a dose of 0.4 mg FA when taken periconceptionally (Werler et al., 1993).

The Werler et al. (1993) findings were supported by a further study, conducted by Berry et al. (1999), that evaluated the use of a FA-only supplement containing 0.4 mg taken periconceptionally up until the end of the first trimester. This study involved a large cohort of 247,831 women from Northern (with high rates of NTDs – 5 to 6 per 1000 births) and Southern (with low rates NTDs – 1 per 1000 births) regions of China, who were asked to take a 0.4 mg supplement as part of a public health campaign. This study also confirmed that taking a 0.4 mg FA-only supplement significantly decreased the incidence of NTD in Chinese pregnant women from both Northern (79% reduction) and Southern regions (16% reduction) (Berry et al., 1999).

Based on the results stemming from the studies mentioned above, the World Health Organization (WHO) recommended that a daily dose of 400 µg (0.4 mg) FA for four weeks leading up to and 12 weeks after conception is sufficient to reduce the risk of NTD (World Health Organization, 2007).

Since these guidelines were developed there has been some research into whether there may be benefits (or risks) to continuing FA supplementation beyond the first trimester. Homocysteine is an amino acid, made during one-carbon metabolism and a deficiency in FA leads to increased levels of homocysteine. In pregnancy, increased levels of homocysteine have been found to be associated with an increased risk of preeclampsia, premature delivery, and very-low birth weight (Cotter et al., 2001, 2003; Vollset et al., 2000). Hence, it has been suggested that by supplementing with FA for longer and preventing the increase in plasma homocysteine levels, could result in a reduction of the incidence of these conditions.

McNulty et al. (2013) conducted the first RCT to show that continuing FA supplementation after the first trimester prevented the normal increase seen in homocysteine levels in the stage of pregnancy. However, to date results from epidemiological studies that have looked at the relationship between FA supplementation and pre-eclampsia and gestational diabetes have been inconclusive. With one meta-analysis suggesting supplementation of MVT containing FA rather than FA alone showed decreased preeclampsia risk (Liu et al., 2018). The case for continuing

to take FA after the first trimester is further weakened with results from a recent international RCT (n=2464) that investigated the efficacy of high dose (4 mg) FA supplementation in women who had at least one risk factor for pre-eclampsia showing no effect on the prevention of pre-eclampsia (Wen et al., 2018).

Other studies have investigated outcomes on the children of mothers who had been supplemented. For example, when the children of the McNulty et al. study were followed up at 3 and 7 years of age, it was found that the children from mothers who had been given FA supplementation scored higher in cognitive tests compared to those whose mother took the placebo supplement, suggesting FA supplementation beyond the first trimester may influence cognitive performance (McNulty et al., 2019). However, a recent meta-analysis which examined the relationship between FA supplementation during pregnancy and childhood asthma risk, concluded that 'folic acid supplementation during pregnancy increases the risk of childhood asthma' (Yang et al., 2022). With dose-response analysis showing the risk significantly increased when the maternal folate intake was greater than 581 µg/day.

Therefore, while conclusive evidence supports the current recommendations to take FA periconceptually and for the first trimester to prevent NTDs, our understanding of any benefits and/or risks in taking FA beyond the first trimester (and at what dose) means it is not possible to make recommendations to take it longer at this time.

2.2.1.1. NZ MOH recommendations for folic acid

In 1993 the NZ MOH, began recommending that women planning a pregnancy increase their daily intake of FA using supplements. Yet, at the time, there was only one available registered medicine that contained 5 mg FA. Later in 1995, a 0.8 mg FA tablet became available and was subsequently recommended to women planning a pregnancy (Ministry of Health, 2003). Currently, this continues to be the only dose available that is recommended and/or prescribed by health professionals for pregnant women today, unless they are at high risk of having a baby with a NTD, in which case the 5mg tablets would be recommended. It should be noted, the 0.8 mg dose is higher than is

recommended in other countries such as Australia, who have stayed with the 0.4 mg dose that is recommended by the WHO (Australian Government, 2021).

The current recommendation from the NZ MOH regarding FA supplementation around pregnancy is:

'For women at low risk of a Neural Tube Defect (NTD) take a folic acid tablet (0.8 mg or 800 µg) every day for 4 weeks (one month) before you might become pregnant through to 12 weeks after becoming pregnant. Women who are affected by a NTD themselves, who have a child with a NTD, close family member or family history of NTD are recommended to take a higher dose of 5 mg (5000 µg) daily. This is also recommended for those who are on insulin for diabetes treatment and those on medications known to effect folate metabolism. The timeframe in which they are recommended to take it remains the same' (Ministry of Health, 2021).

In NZ the 0.8 mg and 5 mg FA tablets can be bought as single nutrient supplements from a Pharmacy or other shops that sell supplements (Chemist Warehouse retail 120 x 0.8 mg FA tablets for \$10.99 (Chemist Warehouse, 2023)) or they may be prescribed by a women's lead maternity carer (LMC), general practitioner, Nurse practitioner or specialist and dispensed at a Pharmacy. At the time of the survey, there was a \$5.00 charge for each prescription, however, chains such as the Chemist Warehouse were not charging the prescription tax, making the prescription free from their stores (Ministry of Health, 2018).

Following the introduction of the recommendation for pregnant women to take a FA supplement, voluntary fortification began in 1996 of certain foods with FA, primarily occurring in breakfast cereals and cereal products. These were identified as foods that were consumed by the target population, that were easy to fortify in the hopes of increasing the folate status of women of child-bearing age. Just after the introduction of FA fortification in 1996, the prevalence of NTD was 9.1 per 10,000 births compared with the latest statistics in 2015 showing a prevalence of 10.6 (Ministry of Health, 2003, 2021). This indicates that the current level of fortification is not having the desired effect of reducing NTDs in NZ. As a result, from 2021, the government has made it mandatory

that all non-organic wheat flour used for making bread will be fortified with a transition period ending August 2023 (Ministry for Primary Industries, 2021; Ministry for Primary Industries, 2022).

2.2.2. Iodine

Iodine is important for the production of thyroid hormones (thyroxine (T_4) and triiodothyronine (T_3)). In human's thyroid hormones have significant roles in growth, development and metabolism, but in the foetus they are essential in the development and proliferation of neural tissue (Velasco et al., 2018). Pregnant women are not only required to produce sufficient thyroid hormones for themselves, but also enough to meet the requirements of the foetus until the foetal thyroid begins functioning around 18 to 20 weeks' gestation. However, foetal iodine supply remains completely dependent on the mother (Moleti et al., 2014; Springer et al., 2017). The increased production of thyroid hormones as well as iodine demand from the developing foetus results in an increased requirement of iodine for pregnant women.

During lactation, an adequate iodine intake is required for maternal thyroid function and iodine is also secreted into breastmilk to support their breastfed infants' thyroid hormone synthesis and thus postnatal neurodevelopment. Following birth, WHO recommends exclusively breastfeeding for the first six months of life, and to continue to breastfeed for up to 2 years of age and above (World Health Organization, 2018). Therefore, it is essential that lactating women have adequate iodine status for their own health and that of their breastfed new-borns.

The recommended daily intake of iodine increases from 150 μg per day to 220 μg per day and 270 μg per day for pregnant and lactating women of any age, respectively (National Health and Medical Research Council, Australian Government Department of Health and Ageing, New Zealand Ministry of Health [NHMRC, AGDHA, NZMOH], 2014).

Table 2. Recommended Iodine intake across different life stages*.

| | Estimated average requirement (EAR) | Recommended dietary intake (RDI) | Upper level of intake (UL) |
|--------------------|-------------------------------------|----------------------------------|----------------------------|
| Non-pregnant women | 100 µg/day | 150 µg/day | 1,100 µg/day |
| Pregnant women | 160 µg/day | 220 µg/day | 14-18 yr 900 µg/day |
| | | | 19-50 yr 1,100 µg/day |
| Lactating women | 190 µg/day | 270 µg/day | 14-18 yr 900 µg/day |
| | | | 19-50 yr 1,100 µg/day |

*National Health and Medical Research Council, Australian Government Department of Health and Ageing, New Zealand Ministry of Health [NHMRC, AGDHA, NZMOH], 2014

Globally, severe iodine deficiency in pregnant women may result in adverse health consequences, such as stillbirth, congenital abnormalities, perinatal and infant mortality, cretinism and delayed physical development (WHO, ICCIDD, UNICEF, 2007; Glinoyer, 2007; Skeaff, 2011). Some evidence suggests that mild to moderate iodine deficiency during pregnancy may impact infant and child neurodevelopment (Abel et al., 2017; Dineva et al., 2020; Levie et al., 2019; Skeaff, 2011). However, further high-quality research studies designed with child cognitive outcomes are needed to corroborate this (Dineva et al., 2020).

In NZ, iodine deficiency has consistently been an issue, due to low levels of iodine present in soil. Since 1924, table salt has been mandatorily iodised which led to a significant reduction in the rate of goitre (enlargement of thyroid glands). However, the problem has since re-emerged which is thought to be due to a range of factors, including public health messages to reduce salt intake and not using iodophors to sanitise milking equipment thereby reducing the amount of iodine that was found in milk (Delziel, 2008).

Iodine fortification of commercial bread excluding organic and leaven breads became mandatory in 2009 in NZ to reduce the prevalence of iodine deficiency within the general population. Where salt was added to bread, it must be iodised to contain no less than 25 mg/kg of iodine and not more than 65 mg/kg of iodine (Ministry for Primary Industries, 2012). At an average level of 45 mg/kg it was estimated that females aged 16-44 years would reach a mean dietary intake of 138 µg/d (Food Standards Australia

and New Zealand, 2008). This would suggest that pregnant and lactating women would be unlikely to meet the recommended intakes of iodine through bread fortification alone. Consequently, iodine-only supplementation was recommended by the NZ MOH in 2010, whereby a subsidised supplement containing 150 µg of iodine was made available to pregnant and breastfeeding women (Ministry of Health, 2010).

The most recent results of the biomedical module from the 2014/15 New Zealand Health survey measuring urinary iodine concentration (UIC) found that iodine status was adequate for women (aged ≥15 years) overall across different ethnicities, but women of European/Other ethnicity were mildly deficient in iodine (Ministry of Health, 2020). However, there is concern for pregnant and lactating women as demonstrated by the following studies.

Results of two studies in NZ that measured UIC, breastmilk iodine concentration (BMIC) levels, and estimated daily iodine intake in pregnant and lactating women, suggest that iodine deficiency was prevalent (Brough et al., 2015; Jin et al., 2021). Brough et al. (2015) conducted a pilot study to examine iodine intake and status in women who were either in their third trimester or who were lactating at least three weeks postpartum at two time points. Before (n= 25 pregnant; 32 lactating) and after (n= 34 pregnant; 36 lactating) two NZ government initiatives (mandatory fortification of bread with iodised salt and a subsidised iodine-only supplement for pregnant and breastfeeding women) were introduced. They found while both UIC levels and daily iodine intake significantly increased after the implementation of the initiatives, both measures still indicated deficiency within the studied cohort. A more recent study of 87 breastfeeding women and their infants at three months postpartum (Jin et al., 2021), found that lactating women were iodine deficient (UIC <100 µg/L) despite the implementation of two government initiative to improve iodine status.

Supplementation is one of the strategies to improve nutrient intake and/or status, thus impact on physiological functions. Three international studies have examined the impact of iodine supplementation on maternal thyroid function in populations of pregnant women who were mild-moderately iodine deficient (Glinoeer et al., 1995; Liesenkötter et al., 1996; Pedersen et al., 1993). Findings suggest that pregnant women

who used iodine supplementation experience less change in thyroid function. These results were seen at a range of iodine doses with no one dose reported to be the ideal dosage.

Firstly, Pedersen et al. (1993) randomly assigned 54 healthy Danish women, from a population with relatively low iodine status, to take either 200 µg iodine/day or a placebo from 17-18 weeks of pregnancy until 12 months after delivery. It was found that the women who had taken iodine supplements throughout their pregnancy experienced no increase in thyroid stimulating hormone (TSH) while an average increase of 121% was observed in the placebo group. Additionally, a smaller increase in thyroid volume (15%) was observed in participants who supplemented with iodine compared to a 30.8% increase in the participants who took the placebo.

Secondly, Glinoe et al. (1995) conducted a RCT in 180 euthyroid Belgian pregnant women identified biochemically as having excessive thyroid stimulation (by having an increased thyroglobulin levels associated with low free T₄ and/or an increased T₃/T₄ ratio). Women received either a placebo, 100 µg iodide or 100 µg iodide plus 100µg L-T₄ per day from the end of the first trimester until term. Similar to Pedersen et al. (1993), women taking iodine supplements, with or without 100 µg L-T₄ per day, experienced a stable TSH production, and the change in thyroid volume that occurred was significantly less (8% and 15% increment) than in the placebo group (30% increment).

Finally, Liesenkötter et al. (1996) studied 108 German pregnant women, 38 who took 300 µg potassium iodide per day from the first trimester and during lactation and 70 who took no supplementation. Unlike the previous two studies, no difference in thyroid volume change was seen between the mothers who received iodine supplements and those that did not, which indicated that iodine supplementation did not prevent an increase in maternal thyroid volume (Liesenkötter et al., 1996), authors had suggested possible reasons, including maternal age and their baseline iodine status.

Another prospective, randomised trial compared two different doses of iodide on thyroid function. Sixty-seven pregnant Italian women living in marginally iodine-deficient area, were supplemented with 200 µg (group A) and 50 µg (group B) of iodide

per day during and after pregnancy (Antonangeli et al., 2002). Slight differences were seen in thyroid volume changes between the two groups, with 45% of women in group B observing a stabilisation or decrease in thyroid volume during pregnancy. However, compared to the three previous studies conducted in mild-moderate iodine deficient populations, these differences were not significant. No significant change in TSH was reported in either group. This study indicates that supplementing with as little as 50 µg iodine per day throughout pregnancy may be beneficial.

In addition, the three studies (Glinöer et al., 1995; Liesenkötter et al., 1996; Pedersen et al., 1993) also reported positive impacts of prenatal iodine supplementation on infants' iodine status and thyroid volume. For example, 10% of new-borns from Belgian mothers in the placebo group experienced thyroid hyperplasia, with no occurrence of goitre observed in others from mothers taking iodine supplements, with or without 100 µg L-T₄ per day (Glinöer et al., 1995), and similar findings from Liesenkötter et al. (1996) showing a significantly lower neonatal thyroid volume (mean ± standard deviation) in the maternal iodine supplementation group (0.7 ± 0.4 mL) than the value in the control group (1.5 ± 1.1 mL). Both suggested that new-borns from mothers who supplemented iodine could be protected from goitrogenesis.

A more recent meta-analysis of cohort studies by Dineva et al. (2020), reported some positive associations of iodine supplementation prior to pregnancy with thyroid function and child neurodevelopment. However, the evidence was inconsistent which may be due to variations in the baseline iodine status or dose/timing/form of supplementation (Dineva et al., 2020). Thus, the optimal dose and timing of iodine supplementation for both mother and infants may require further investigation.

2.2.2.1. NZ MOH recommendations for iodine

The current recommendation from the NZ MOH regarding iodine supplementation around pregnancy is:

'Take one 0.150 mg or 150 µg iodine-only tablet every day when pregnant and breastfeeding'. (Ministry of Health, 2020, p38).

The government subsidised iodine-only supplements are readily available through prescription or over the counter.

There appears to be some debate as to when the best time to commence iodine is. This is reflected in the differences between the recommendations in Australia and NZ, with the National Health and Medical Research Council of Australia recommending commencing supplementation when a woman is considering pregnancy (NHMRC, 2010).

Some evidence has suggested that adequate iodine intake (either from iodised salt or supplements) during the preconception period, maximises thyroid iodine stores and potentially decreases the changes in thyroid function and thyroid hormone production during pregnancy (Katko et al., 2018; Moleti et al., 2011; Moleti et al., 2008; Santiago et al., 2013). In 2019, Hay et al., published a concept paper which recommended the initiation of iodine supplementation should be during the preconception period, to take into account the required lag time from ingestion to it being fully incorporated into thyroid hormones and their stores, and that missing this crucial window may lead to impaired development in foetal brain (Hay et al., 2019). As more evidence becomes available it is likely the NZ recommendation will be reviewed.

2.2.3. Multivitamins and other supplements

Other nutrient supplements may be recommended to pregnant and breastfeeding women but are only given to those who are identified as deficient or are at risk of deficiency. These include iron, vitamin D and vitamin B12 which are given to women where a specific need is identified. For example, in the case of vitamin D, women who have darker skin or those susceptible to decreased sun exposure and in the case of vitamin B12, women who are vegans.

In the case of iron, around the second trimester of pregnancy, maternal plasma volume and oxygen consumption increase, the size of the placenta increases, and iron is transferred to the foetus and preparation for blood loss during delivery occurs, all of

which increase iron requirements (Bothwell, 2000; Fisher & Nemeth, 2017; Tan & Tan, 2013). Thus, the RDI increases from 18mg/day for women of child-bearing age to 27mg/day for pregnant women (NHMRC, AGDHA, NZMOH, 2014). This can be challenging to meet through diet alone, especially for women who are vegetarian or vegan. Further, a woman's iron stores prior to pregnancy play a large role in whether the increased requirements during this time can be met. The most recent results of the biomedical module from the 2014/15 New Zealand Health survey found that 29.4% of women aged 15-44 years were anaemic (severe iron deficiency) (Ministry of Health, 2020). This indicates that a large proportion of women of childbearing age may enter pregnancy with insufficient iron stores.

Although routine vitamin supplementation (other than what is recommended by the NZ MOH) is not necessary during pregnancy and breastfeeding, there is an increasing array of specific MVT and other products available to pregnant and lactating women who recognise or perceive they might not be meeting their nutrient requirements for micronutrients such as iron through diet alone. One such product is Elevit®, which markets itself as NZs number one preconception and pregnancy MVT and mineral supplement that is 'specifically formulated to help meet the increased nutritional needs of women who are trying to conceive and are pregnant' (Elevit, 2023). This product is extensively advertised to women trying to conceive, as well as those that are pregnant and breastfeeding.

A cross-sectional NZ study, conducted in 2020, utilising questionnaires to explore dietary choices of pregnant and lactating women in NZ (n= 458), found that 70% of participants during pregnancy and 60% during the first six weeks of lactation took supplements other than the recommended single nutrient FA and iodine supplements (Brown et al., 2020). These included but were not exclusive to an assortment of MVT tablets and single nutrient supplements such as iron, calcium, zinc and magnesium as well as other products such as probiotics, fish oil, Chinese herbs and collagen.

Some research suggests women are taking MVT supplements either instead of or in addition to taking separate FA and iodine supplements. In the Screening for Pregnancy

Endpoints study (SCOPE), data from NZ participants (Auckland only, n= 1960) was used to complete a retrospective cross-sectional analysis to examine the relationship between reported FA supplement use and plasma levels at 15 weeks' gestation. It was found that 73% of NZ women reported taking a FA-containing supplement at 15 weeks' gestation (Bulloch et al., 2019). However, only 21% reported consuming FA as a single nutrient supplement, with the rest taking a FA-containing MVT supplement (of varying FA levels) or both (FA-containing MVT supplement and single nutrient supplement). A small number (1.4%) reported taking a MVT supplement that contained no FA (Bulloch et al., 2019).

Given this information, it is important that if women decide to take alternative supplements such as MVT, they should be taking one that is specifically targeted for pregnancy. Standard MVT can contain micronutrients at levels which can do harm. For example, high levels of vitamin A, (more than 10,000 IU of preformed vitamin A per day in the form of supplements) which if take during early pregnancy can be associated with increased risks of birth defects (Rothman et al., 1995). Furthermore, due to the increased availability of supplements on the market in store and online, it is important that women are aware of the supplementation recommendations for during pregnancy and lactation. There is also a need for supplements that are marketed for pregnancy, to provide safe formulations with adequate doses of nutrients such as FA and iodine. Currently there is limited readily accessible information available on what doses of FA and/or iodine different MVT supplements contain and whether the doses align with what women should be taking.

2.3. Adherence to the NZ Ministry of Health recommendations and associated factors

Although the MOH has recommendations for FA and iodine it does not mean that they are followed by all women. It is important therefore, that we have a good understanding of the degree to which women adhere to the NZ MOH recommendations and what factors might be influencing their supplement use.

2.3.1. Folic acid

Ideally, women would begin taking a FA supplement at least four weeks prior to becoming pregnant and continue taking it until the end of the first trimester. Current literature suggests that many NZ women are not meeting these recommendations with one of the main reasons being an unplanned pregnancy.

The 2014/15 New Zealand Health Survey 5,840 females completed the Sexual and Reproductive Health module. They found that one-third of women (aged 16 to 44 years) had been pregnant in the last 5 years. Of these pregnancies 14% were unplanned and 32% were reported as ambivalent (Ministry of Health, 2019). Forty-eight percent of respondents reported taking FA supplements prior to their pregnancy, with the percentage increasing with age. By ethnicity, Māori and Pacific women were 0.8 and 0.7 times less likely to have taken FA supplements prior to their pregnancy, respectively, compared to their non-Māori and non-Pacific counterparts (Ministry of Health, 2019).

The Vitamins and Minerals in Pregnancy Survey recruited postpartum women in maternity wards throughout NZ (n= 723) and aimed to explore knowledge around of current FA recommendations and consumer behaviour prior to the potential implementation of mandatory FA fortification of bread in 2012. The researchers found while nearly all women with planned pregnancies had heard of FA, only 54% of them took FA supplements as recommended during the preconception period. In contrast only 3.3% of women with unplanned pregnancies took FA supplements and they were less likely to have heard of FA, be aware that it reduced NTDs, and that it should be taken periconceptually (Mallard & Houghton, 2012).

Results published from the 'Growing Up in New Zealand' (GUiNZ) cohort study (n=6822), a large nationally representative longitudinal study highlighted the need for further investigation into what and how FA supplements were being taken throughout pregnancy. Women whose children were born between 2009-2010 were recruited while pregnant. Participants were asked if they had taken folate or FA, even as part of a MVT, how many days per week on average and for how many weeks. Overall, they found that 92% of women had not taken a FA supplement as recommended, with 69% having an

insufficient use and 57% using FA beyond the first trimester, based on the number of days and/or duration that women reported, not the actual dose taken per day. Thirteen percent of women reported not taking a FA-containing supplement at all (Teixeira et al., 2018). Age, pregnancy planning, parity, ethnicity, education, and smoking were found in multivariate analysis to be associated with both not taking any and insufficient use. They also, identified that more than 60% of the women who reported taking a FA supplement during their pregnancy had been dispensed a subsidised FA or FA-containing supplement, rather they were buying their supplement from pharmacies or elsewhere. (Teixeira et al., 2018).

GUINZ also looked separately at FA supplement use before pregnancy and reported that only 39% of participants took a FA supplement before pregnancy (Morton et al., 2013). Factors that were associated with whether FA supplementation was initiated prior to pregnancy included ethnicity, education level, age, socio-economic status and whether the pregnancy was planned (Morton et al., 2013). Women of European ethnicity, women who had received higher education, were older, were living in a household in the least deprived quintile of NZ households and had planned their pregnancy were all more likely to have begun FA supplementation prior to conception compared to their counterparts.

A 2017 cross-sectional online survey of 535 women from around NZ looked at supplement use and adherence to supplement recommendations for FA and iodine, pre-pregnancy and during pregnancy and breastfeeding. In their short communication the researchers reported that only 50% of participants reported taking at least 400 µg of FA per day (Reynolds & Skeaff, 2018). The use of FA during the different time periods was not reported, nor was data on the actual dose and frequency of dose.

Results from the SCOPE study (n= 1960) found that 67% of participants had taken a FA supplement pre-conception, 97% during their first trimester and 73% of participants were still taking FA at 15 weeks (Bulloch et al., 2019). Only 48% of participants supplemented with FA as recommended (before pregnancy as well as during the first trimester). Of the women still taking FA at 15 weeks (early second trimester) 76% were

taking a daily dose of ≥ 0.8 mg. At 15 weeks age, ethnicity, socio-economic index and smoking status were found to be significantly associated with FA supplement use/non-use.

In their cross-sectional study Brown et al. (2020) recruited pregnant and lactating NZ women (n= 458) who completed an online survey which included questions on supplement use. The researchers reported that 96% of participants took FA, at some point during their pregnancy. However, this study did not report the dose, frequency and duration of use of FA. Additionally, Brown et al. (2020) reported that 26% of participants continued to take FA supplements while breastfeeding for at least the first six weeks post-partum.

2.3.2. Iodine

Supplementation with 150 μg iodine is recommended from the time a woman is aware she is pregnant until cessation of breastfeeding in NZ. Currently, there is a lack of detailed evidence around what specific dosages of iodine are being taken and at what time periods throughout pregnancy.

One study of pregnant and lactating women was conducted in Palmerston North between 2009 and 2011. Participants were recruited prior to and after the implementation of government initiatives to increase the iodine status of the population. It was found that in the 68 women recruited in 2011 (post-implementation) only 70% were taking iodine-containing supplements (Brough et al., 2015). It was also reported that not all the supplements being taken contained the recommended amount of iodine. More recently, Brown et al. (2020), reported that 95% of participants supplemented with iodine at some point while they were pregnant. However, in this study the amount of iodine taken and when the supplement was taken was not assessed.

The Mother and Infant Nutrition Investigation (MINI) study, which recruited a cohort of women from Palmerston North in 2016/17 (n= 87), reported 86% of the participants

took iodine-containing supplements during pregnancy (Jin et al., 2021). This study found that on average, the supplements these participants were taking contained 150-270 µg of iodine, with almost 80% of participants taking the government subsidised tablet (150 µg of iodine).

In their online survey, Reynolds and Skeaff (2018) reported that 52% of their participants (pregnant women, n=535) supplemented with at least 150 µg iodine per day within two years of the study time. However, the use of iodine supplements during the different time periods was not reported, and data on the actual dose and frequency of dose were not included.

Evidence from the few studies that have examined iodine supplementation while breast-feeding in NZ, suggest that rates are low. The amount of iodine these women are taking also varies greatly, with some women taking less than what is recommended. The MINI study reported that just below half of participants continued to take iodine supplements (containing 100-250 µg iodine per day) for at least the first three months of lactation, with 58% of these women taking the government subsidised supplement. Both Brough et al. (2015), and Brown et al. (2020), reported that less women were taking supplements containing iodine while they were breastfeeding, compared to when they had been pregnant (70% versus 36% and 95% versus 63% respectively). Additionally, Brough et al. (2015), found that some of the iodine supplements being taken during this time contained less than the recommended 150 µg. This evidence suggests that only a small number of women would be using iodine supplements in line with what is recommended by the NZ MOH.

There are few studies in NZ that have reported factors associated with iodine supplement use throughout pregnancy. In 2014, although not looking at iodine intake supplement use alone, Mallard & Houghton found that women who were younger, had more children and had unplanned pregnancies were more likely to have a lower iodine intake (less than the EAR) from dietary supplements, bread and iodised salt. While more recently in 2021, Jin et al. reported that habitual iodine supplement use during pregnancy was associated with education attainment, however no associations were

found with habitual iodine supplement use during lactation. Additionally, there have been some Australian studies. A cross-sectional study of pregnant women (n= 425) conducted in Perth by Hine et al. between 2012 and 2013 reported that age, maternal income and first-time pregnancy were associated with iodine supplement use during pregnancy (Hine et al., 2018). In another, cross-sectional online survey of 857 pregnant women from across Australia the researchers identified that planned pregnancy was associated with iodine supplement use during pregnancy (Malek et al., 2016).

It is difficult to fully comment on current supplement adherence to the MOH recommendations due to the variation in results reported and the different scopes of supplementation use that was assessed by different studies. Several of the studies have not assessed and/or specified the dose of FA or iodine taken by participants, frequency of dose, how long before conception the supplements were taken, explored the specific supplements taken or whether women were taking more than one supplement containing FA or iodine. It is clear however, that FA and iodine supplementation rates around pregnancy are high, however only a limited proportion of women are supplementing with these nutrients as recommended by the NZ MOH. Further, a number of factors such as unplanned pregnancy, age, education, ethnicity, income and socioeconomic factors have been identified as being associated with either following or not following the recommendations. There has been however, less research conducted on adherence of iodine supplementation compared to FA supplementation.

2.4. Concluding statement

Nutritional supplementation is a complex topic to investigate, particularly around such a vulnerable time such as pregnancy and lactation, as use of supplements can be influenced by a range of factors most of which are extremely specific to an individual. Although there is some information around FA and iodine supplement use by pregnant NZ women, there are currently a number of gaps within the literature. These include what specific single nutrient and FA and iodine-containing MVT supplements women are choosing to take preconception, during the three stages of pregnancy and during the post-partum period while lactating. Further whether the dose and time period that

women are taking these supplements, aligns with what is recommended by the NZ MOH. Additionally, few studies have looked at the range of MVT supplements being taken by women and the amount of FA and iodine these contain.

Further, while a number of the studies examined in this literature review have identified various factors that are associated with whether a woman is meeting or not meeting the recommended recommendations for taking FA. Limited research appears to have investigated the factors associated with iodine supplementation in New Zealand.

It is also important that regular studies are conducted to examine what women are choosing to take before, during and after pregnancy to assist in identifying any areas where additional education of women of child-bearing age and health professionals may be required to support pregnant and lactating women in meeting the current FA and iodine recommendations.

Chapter 3: Folic acid and iodine supplement use: a cross-sectional survey from preconception through to six weeks post-partum in New Zealand women

3.1. Abstract

Background: At different times around pregnancy, it is recommended that women take folic acid (FA) (0.8 mg and 5 mg for high-risk individuals) and/or iodine (150 µg) containing supplements. This cross-sectional study, in post-partum women, aims to investigate what supplements were taken and whether the use aligned with the NZ MOH recommendations.

Methods: Eligible women completed a self-administered online questionnaire on FA, iodine and multivitamin (MVT) use around pregnancy. Descriptive statistics were used to describe the participants supplement usage.

Results: Women from around NZ (n= 584) took a range of 31 different supplements that contained FA and/or iodine. For FA, 58% (preconception) and 96% (first trimester pregnancy) of women took FA-containing supplements, with 30% and 61% taking single nutrient supplements only, 18% and 17% from MVT only, and 10% and 19% taking both. Based on the MOH recommendations, only 30% (preconception) and 62% (first trimester) achieved sufficiency of FA supplementation at 0.8 mg/day; 35% (preconception) and 69% (first trimester) achieved sufficiency of FA at 5 mg/day. More than 75% of women reported taking iodine-containing supplements during pregnancy (first and second trimesters: 93%, third trimester: 89%) and postpartum (76%). Approximately 60% took single nutrient supplements, 18% took only MVT and 14% took both. Around 50% women achieved sufficiency of iodine supplementation at 150 µg/day during pregnancy while only 37% during postpartum.

Conclusion: While up to 95% of women reported taking sufficient FA and iodine at some point during their pregnancy, the majority are not taking these supplements at the NZ MOH recommended doses during the recommended time periods.

3.2. Introduction

Pregnancy and breastfeeding are two life-stages where maternal physiological changes and the demands of a growing foetus or infant mean there are increased requirements of certain nutrients (Jouanne et al., 2021; Molloy et al., 2008; Picciano, 2003). Two nutrients of particular concern during these life stages are FA and iodine.

The consequences of inadequate intake of these nutrients have been widely documented and include birth defects in the case of FA and inadequate thyroid hormone synthesis and impaired neuro development in the case of iodine (Christesen et al., 2012; Czeizel & Dudás, 1992; Medical Research Council, 1991; Molloy et al., 2008; Pludowski et al., 2013; Skeaff, 2011; Velasco et al., 2018; Wagner et al., 2008). A number of studies have recognised that supplementation of both FA and iodine in populations that have low intakes of these nutrients or may be at risk of deficiency significantly improves pregnancy and birth outcomes (Antonangeli et al., 2002; Berry et al., 1999; Laurence et al., 1981; Medical Research Council, 1991; Pedersen et al., 1993; Werler et al., 1993).

In response to this evidence, the World Health Organization (WHO) developed recommendations around supplementation that align with the increased requirements of these two nutrients. Taking these into account, but also factors such as NZ's history of having an inadequate iodine status, the NZ MOH developed its own recommendations for both FA and iodine supplementation around pregnancy and lactation (MOH, 2018). For FA the recommendation is to take 0.8 mg FA/day, or 5 mg for those at higher risk of having a child with a NTD, from 4 weeks pre-conception until 12 weeks after becoming pregnant (the end of the first trimester) and for iodine the recommendation is to take 150 µg/day of iodine from conception until the cessation of

breastfeeding. These single nutrient supplements can be prescribed by a health professional or purchased over the counter.

Evidence suggests that NZ women are regularly using a variety of supplements before, during and after pregnancy including a range of MVT that may or may not contain the recommended dose of FA and iodine, as well as single nutrient tablets (Bulloch et al., 2019; Dobson et al., 2006; Morton et al., 2013; Teixeira et al., 2018).

Few studies have gathered the required information to determine the total daily dose taken from both single nutrient and MVT sources for FA and/or iodine and examine how well the supplement use for FA and iodine by pregnant women aligns with the current NZ MOH recommendations. In the case of FA, both the SCOPE (Screening for Pregnancy Endpoints) and GUiNZ (Growing up in NZ) studies identified many women were either taking more FA daily than is recommended and/or were taking it past the end of the first trimester (Bulloch et al., 2019; Teixeira et al., 2018).

Overall, FA supplement use has been identified as being more likely to align with the MOH guidelines during the first trimester of pregnancy once women are aware they are pregnant and iodine supplement use tends to be higher during pregnancy than whilst breastfeeding (Brough et al., 2015; Bulloch et al., 2019; Jin et al., 2021; Mallard & Houghton, 2012; Morton et al., 2013; Reynolds & Skeaff, 2018; Teixeira et al., 2018).

Several factors have been associated with FA supplement use in NZ including age, education, socio-economic status and whether the pregnancy was planned (Dobson et al., 2006; Morton et al., 2013; Teixeira et al., 2018). Some of the same factors including age, income and whether the pregnancy was planned, as well as if this was the mothers first pregnancy have been identified as being associated with iodine supplement use in studies conducted in Australia (Hine et al., 2018; Malek et al., 2016). However, only two studies have explored these relationships/associations in NZ and found that low education status and low income was associated with being less likely to have taken iodine supplements and knowledge of iodine was associated with having taken iodine supplements (Jin et al., 2021; Mallard & Houghton, 2014).

This aim of the present study was to investigate what nutritional supplements containing FA and/or iodine were taken by a cohort of post-partum women in NZ, during the preconception period (three months before), during the three trimesters of pregnancy and post-partum (first six weeks following childbirth). This study examined how well the women's supplement use aligned with the NZ MOH recommendations, along with what factors might be associated with having a sufficient supplement intake. Finally, supplements that are promoted to pregnant and breastfeeding women in NZ have been identified and assessed to determine if the recommended daily dose aligns with the NZ MOH recommendations for FA and iodine.

3.3. Methods

This cross-sectional observational study utilised data gathered on FA and iodine supplement use (both from single nutrient and MVT supplements), from an anonymous online questionnaire that was accessible to women around NZ, which collected data on the wider supplement use of women who had recently given birth.

3.3.1. Sample size calculation

Using data from Statistics NZ, the average total live births per year recorded in NZ between the months of February and July in 2019-2021 was 29,393. Applying the recruitment rate captured by Brown et al (2020) of 1-1.5% of live births recorded during their six-month recruitment period in 2019, this study aimed to recruit a sample size of 370 postpartum women over a similar length period.

3.3.2. Recruitment and participants

Women who had recently given birth throughout NZ were recruited between February and mid-August 2022 via social media, professional associations, word of mouth and personal contact (Appendix E and F). Prospective participants were given a link to the questionnaire where they were taken to a summarised 'Information Sheet' (Appendix D). On the same page, prospective participants could also find a link to the full 'Information Sheet' (Appendix C) and contact details to ask any questions before commencing the study. Informed consent was confirmed by choosing the statement

"yes, I consent to my response to this survey being included in the research", that needed to be completed, before they could start the questionnaire.

The inclusion criteria included individuals who had given birth within six months prior to their recruitment date, be 18 years of age or older, reside in NZ, be proficient in the English language and be able to complete the questionnaire online. Individuals were excluded if they had used assisted reproductive technologies to become pregnant (due to increased level of care from specialists').

3.3.3. Identification of multivitamin supplements that contain folic acid and iodine

To inform the questionnaire design, an online search of pharmacy websites, including Pharmacy Direct and Chemist Warehouse was conducted of what MVT supplements that contained FA and/or iodine were available in NZ that were marketed towards women trying to conceive, or who were pregnant or breastfeeding. This was conducted in September 2021. Supplements were audited for their FA and/or iodine content, and the manufacturers' recommended daily intake for the product (Appendix A1). Pictures of these supplements were used in the questionnaire to make it easier for identification.

3.3.4. Questionnaire

The questionnaire was developed by the research team based on the questionnaires from the Growing Up in New Zealand study (GUINZ) and the Maternal Dietary Choice study in NZ conducted by Brown et al (2020).

The questionnaire comprised of three sections: Section one - Eligibility screening questions, to confirm participants did meet the inclusion criteria; Section two – Maternal information, which included questions on age, ethnicity, qualifications, geographical location, and income, followed by questions about their pregnancy including parity, planned pregnancy, medical history and lead carer for their pregnancy; Section three - Supplement use questions. This section was further divided into five subsections that examined different types of supplements (1. FA-only tablets; 2. Iodine-

only tablets; 3. Iron-only tablets 4. Multivitamin preparations that contained FA and/or iodine; 5. Other supplements).

Each subsection contained six common questions: 1) why the supplement was taken; 2) how often and at what stages of pregnancy and lactation the supplement was taken; 3) where they received information about the supplement; 4) who prescribed the supplement (if it had been prescribed), 5) if their Lead Maternity Carer (LMC) was aware the supplement was being taken, and 6) where the supplement was obtained from. As well as questions specific to each supplement. For example, for FA and iodine if the participant selected that they had not taken that supplement, they were prompted to explain why they had not taken it, before skipping the to the next subsection. At the end of the questionnaire, two open-ended questions were used to collect data on any other supplements participants used around pregnancy and possible impact by Covid 19 (Appendix D).

The five stages (timepoints) when supplement use was examined were defined as the three months before pregnancy, the three trimesters of pregnancy and six weeks post-partum. The three-month period before pregnancy was used as a surrogate time point for the 4 weeks before pregnancy when it is recommended FA is taken. This was the same period used by GUINZ when they examined FA use during preconception. The six weeks following birth was used as a surrogate time point for taking iodine while breastfeeding. This time point was chosen as a period when many women would be breastfeeding.

The questionnaire was produced using the online software, Qualtrics XM (July, 2022). It took approximately 10-15 minutes to complete. A mixture of closed and open questions were used to maximise responses as well as gain further information. Particular questions were required to be answered to ensure a complete data set, where other questions utilised the option 'Choose not to answer' or 'I cannot remember/do not know' to skip the question.

The questionnaire was peer reviewed by colleagues at Massey University and then pre-tested by a number of women of child-bearing age for the logic flow of question, appropriate level of readability and understanding. Ethical approval for the study was sought to the Massey University Human Ethics Committee (MUHEC; Ethics approval no. 4000025351).

3.3.5. Statistical analysis

The online questionnaire data was downloaded and entered into Microsoft Excel, with subjects only identified by their unique study number. All statistical analysis was performed using IBM SPSS Statistics (version 27). Descriptive statistics including frequency and percentages, and median (25, 75 percentiles) were used to describe the data.

Folic acid and iodine weekly intakes from supplements (including single nutrient and MVT) were calculated by multiplying the amount of nutrient in each supplement, with the number of times taken per day, and the average number of days per week they reported taking the supplement (Table 3). For example, for a woman taking a FA-only supplement (once a day, 1 to 2 days per week) without using other supplements containing FA, her weekly intake will be $0.8 \text{ mg} * 1 * 1.5 ((1 + 2) / 2) = 1.2 \text{ mg/week}$.

Table 3. Responses from the frequency question used in the calculation of weekly intake.

| On average how often did you take xxx supplements | The average number of days per week |
|---|-------------------------------------|
| Most days of the week (6 to 7 days per week) | 6.5 |
| Some days of the week (3 to 5 days per week) | 4 |
| A few days of the week (1 to 2 days per week) | 1.5 |
| Sporadically (less than once a week) | 0.5 |
| Not taken and do not know/cannot remember | 0 |

The calculated individual weekly intake will be compared to the recommended weekly intakes from the MOH guidelines (FA: $0.8 \text{ mg/day} * 6.5 \text{ days/week} = 5.2 \text{ mg/week}$ or $5 \text{ mg/day} * 6.5 \text{ days/week} = 32.5 \text{ mg/week}$; iodine: $150 \text{ } \mu\text{g/day} * 6.5 \text{ days/week} = 975 \text{ } \mu\text{g/week}$).

The weekly intakes were used to classify participants into four groups to describe their level of supplement use:

- none (0 mg/week or 0 µg/week),
- insufficient (< 5.2 or 32.5 mg/week or <975/µg/week),
- sufficient (= 5.2 or 32.5 mg/week or = 975/µg/week),
- and exceeding (> 5.2 or >32.5 mg/week or > 975/µg/week).

Binary logistic regression was used to identify the associations between the levels of FA and iodine supplement usage and selected sociodemographic characteristics. For this analysis those in the 'none' and 'insufficient' groups were combined to form one group and the 'sufficient' and 'exceeding' groups to form a second group. The multivariate-adjusted models included potential determinants of supplement use including age and ethnicity of participants, education, total household income, whether the pregnancy was their first and if the pregnancy had been planned, self-reported health before pregnancy as well as supplement use before pregnancy (Appendix A3). Differences were considered significant at $P < 0.05$.

3.4. Results

3.4.1. Characteristics of the study population

Of the 863 responses to the questionnaire, 584 participants were included in the final analysis. Of the remainder ($n = 279$) 202 women did not finish the main questionnaire and 77 only completed the eligibility screening questions but were excluded due to being pregnant at the time of completion, having given birth over six months before completion or having used assisted reproductive technologies to become pregnant.

The women who participated in this study were predominately well-educated, NZ-born Europeans from high income households (Table 4). Half (50%) of the participants reported that this was their first pregnancy, with the majority of women having planned their pregnancy (84%) (Table 5). Most had a midwife as their main LMC (88%). Two thirds (66%) of participants reported excellent or very good health prior to pregnancy, and 30% reported regular supplement use prior to pregnancy. Almost all participants reported

breastfeeding at some point post-partum, pumping included (98%) (Table 5). The median age of newborns at time of participation was three months old (2, 5).

Table 4. Socio-demographic characteristics (n= 584).

| | | Total n (%) |
|-------------------------------------|---|-------------|
| Age | 18-25 years | 46 (8%) |
| | 26-35 years | 463 (79%) |
| | 36-40 years | 70 (12%) |
| | >40 years | 5 (1%) |
| Ethnicity ¹ | NZ European/Pakeha | 501 (86%) |
| | New Zealand Māori | 26 (4%) |
| | Pacific Island | 7 (1%) |
| | Asian | 11 (2%) |
| | Other ² | 38 (7%) |
| New Zealand born | Yes | 479 (82%) |
| Qualification | Bachelor's Degree or higher | 438 (75%) |
| | Diploma/Polytechnic qualification/Trade certificate | 84 (14.5%) |
| | Secondary school | 59 (10%) |
| | Other (<i>didn't specify</i>) | 1 (0.2%) |
| | No qualifications | 2 (0.3%) |
| Total household income ³ | <\$100,000 | 123 (21%) |
| | \$100,000 but less than \$150,000 | 210 (37%) |
| | \$150,000 or more | 239 (42%) |

¹Total n = 583, 1 participant preferred not to answer

²Other ethnicities: American Jewish, Other European, Russian, South African, South American

³Total n = 572, 12 participants preferred not to answer or did not know

Table 5. Characteristics of participants pregnancy (n= 584).

| | | Total n (%) |
|--|------------------------------------|-------------|
| First pregnancy | No | 294 (50%) |
| Number of other children | One | 191 (65%) |
| | Two or more | 93 (32%) |
| | Other | 10 (3%) |
| Planned pregnancy | Yes | 488 (84%) |
| Breastfed (at some point after childbirth – expressing included) | Yes | 571 (98%) |
| Maternal health prior to this pregnancy | Excellent/Very Good | 382 (66%) |
| | Good | 162 (28%) |
| | Fair/Poor | 40 (6%) |
| Frequency of general supplement use prior to this pregnancy | Regularly | 175 (30%) |
| | Occasionally | 222 (38%) |
| | Never | 187 (32%) |
| Lead Maternity Carer | Midwife | 515 (88%) |
| | Doctor (GP – General Practitioner) | 2 (1%) |
| | Obstetrician (Specialist) | 56 (10%) |
| | Other ¹ | 11 (2%) |

¹Other LMC: Both midwife and obstetrician

3.4.2. Identified supplements that contain folic acid and iodine

Through the supplement auditing of NZ websites, a total of 16 MVT supplements were identified that were marketed towards women trying to conceive, were pregnant or breastfeeding. In addition to containing FA and iodine these supplements contained other vitamins and minerals such as vitamin C, D and E, iron, calcium, magnesium and zinc. (Appendix. A1)

Only one MVT supplement, Elevit® (which is taken once a day) contained 0.8 mg FA which aligns with what is recommended in NZ for most women. The other MVT supplements contained between 0.15 mg and 0.5 mg of FA. For iodine, six contained the recommended amount of 150 µg, with the remainder containing more or less than 150 µg iodine (highest 250 µg).

3.4.3. Use of folic acid and iodine supplements and their adherence to the Ministry of Health recommendations

The following table describes how the participants in this study were supplementing with FA and iodine.

Table 6. Single nutrient, multivitamin and combined supplements usage.

| | Single nutrient only | Multivitamin only | Single nutrient and multivitamin | Neither |
|------------------------------------|----------------------|-------------------|----------------------------------|-------------|
| Folic acid | | | | |
| Recommended period* | | | | |
| Three months prior ¹ | 163 (30.0%) | 100 (18.3%) | 52 (9.5%) | 230 (42.2%) |
| First trimester ¹ | 330 (60.5%) | 90 (16.5%) | 105 (19.3%) | 20 (3.7%) |
| Non-recommended period | | | | |
| Second trimester ¹ | 190 (34.9%) | 117 (21.5%) | 59 (10.8%) | 179 (32.8%) |
| Third trimester ¹ | 123 (22.6%) | 133 (24.4%) | 37 (6.8%) | 252 (46.2%) |
| Six weeks post-partum ² | 61 (10.9%) | 115 (20.6%) | 31 (5.5%) | 352 (63.0%) |
| Iodine | | | | |
| Non-Recommended period | | | | |
| Three months prior ¹ | 82 (15.0%) | 115 (21.2%) | 36 (6.6%) | 312 (57.2%) |
| Recommended period* | | | | |
| First trimester ¹ | 315 (57.8%) | 100 (18.3%) | 94 (17.2%) | 36 (6.6%) |
| Second trimester ¹ | 330 (60.6%) | 98 (18.0%) | 77 (14.1%) | 40 (7.3%) |
| Third trimester ¹ | 319 (58.5%) | 100 (18.3%) | 69 (12.7%) | 57 (10.5%) |

| | | | | |
|------------------------------------|-------------|------------|------------|-------------|
| Six weeks post-partum ² | 278 (49.7%) | 89 (15.9%) | 56 (10.0%) | 136 (24.3%) |
|------------------------------------|-------------|------------|------------|-------------|

¹n = 545 prior to and during pregnancy (excludes participants who did not specify which multivitamin they took)

²n = 559 post-partum (excludes participants who did not specify which multivitamin they took)

*Recommended period for FA = 4 weeks before becoming pregnant (three-month period before pregnancy was used as a surrogate for this time point) and the first 12 weeks of pregnancy; Recommended period for iodine = during pregnancy and while breastfeeding (6 weeks post-partum was used as a surrogate for this time point) (Ministry of Health, 2021; Ministry of Health 2020).

During the recommended periods, the majority of women took the recommended single nutrient supplement for FA (0.8 mg or 5 mg) and iodine (150 µg). Of those who took a MVT, the most popular brand was Elevit® which contained the recommended amount of FA but a higher than recommended dose of iodine (250 µg), followed by Blackmores Pregnancy and Breastfeeding Gold which contained the recommended dose of iodine but a lower than recommended dose of FA (0.5 mg/tablet)

A total of 28 different brands of MVT were taken during the preconception/pregnancy period and 26 brands during the post-partum period that contained between 0.15 mg (Berocca = 0.15 mg/1 tablet daily) – 1.0 mg (Thorne basic prenatal = 1.0 mg/3 capsules daily) of FA per recommended dose and 37.5 µg (Solgar Prenatal Nutrients = 37.5 µg/1 tablet daily) – 299 µg (Metagenics = 299 µg/2 tablets daily) of iodine per recommended dose. In addition to the FA and iodine-containing MVT supplements identified as available to purchase in NZ that are marketed towards women trying to conceive, or who were pregnant or breastfeeding, some were purchased from online providers, some of which are outside of NZ, with the remainder being not pregnancy specific MVT such as Centrum, Healtheries Women’s Multi and BePure One. (Appendix A2).

Folic acid supplement use in women with low risk of having a baby with a NTD

During the three months prior to pregnancy 29.8% of participants reported consuming the recommended amount of FA and met the NZ MOH recommendations, however, 44.0% reported taking no FA during this time. During the first trimester, a larger proportion (62.2%) of participants reported consuming the recommended amount of FA with an additional 17.7% consuming more than recommended. During the non-

recommended period, FA supplement use remained high but did decrease by the post-partum period with the majority (62.8%) taking no FA (Table 7).

Table 7. Proportion of women meeting New Zealand Ministry of Health recommendations based on average weekly folic acid intake from both folic acid-only tablet (0.8 mg) and folic acid-containing multivitamins¹.

| | None ² | Insufficient ³ | Sufficient ⁴ | Exceeding ⁵ |
|-------------------------------|-------------------|---------------------------|-------------------------|------------------------|
| Recommended period* | | | | |
| Three months prior | 215 (44.0%) | 95 (19.5%) | 145 (29.8%) | 32 (6.6%) |
| First trimester | 20 (4.1%) | 78 (16.0%) | 312 (62.2%) | 86 (17.7%) |
| Non-recommended period | | | | |
| Second trimester | 157 (32.2%) | 139 (28.5%) | 158 (32.4%) | 33 (6.8%) |
| Third trimester | 218 (44.8%) | 121 (24.8%) | 123 (25.3%) | 25 (5.1%) |
| Six weeks post-partum | 314 (62.8%) | 132 (26.4%) | 41 (8.2%) | 13 (2.6%) |

¹n = 487 prior to and during pregnancy and n = 500 post-partum (excludes participants who did not specify which multivitamin they took and 62 participants who were prescribed 5mg FA-only tablet). ²None = 0mg/week. ³Insufficient = 0.01-<5.2 mg/week. ⁴Sufficient = 5.2 mg/week. ⁵Exceeding = >5.2 mg/week (reported dose per day x reported average frequency of consumption per week. See methods for details of calculation).

*Recommended period for FA = 4 weeks before becoming pregnant (three-month period before pregnancy was used as a surrogate for this time point) and the first 12 weeks of pregnancy (Ministry of Health, 2021).

Folic acid supplement use in women with high risk of having a baby with a NTD

During the three months prior to pregnancy 34.5% of participants reported consuming FA as recommended by the NZ MOH however, 25.9% reported taking no FA at this time. During the first trimester, all participants reported taking supplements that contained FA with 69.0% consuming the recommended amount and almost a quarter (24.1%) taking more than recommended. FA supplement use continued during the non-recommended period but did decrease towards the end of pregnancy and during the post-partum period (Table 8).

Table 8. Proportion of women meeting New Zealand Ministry of Health recommendations based on average weekly folic acid intake from both folic acid-only tablet (5 mg) and folic acid-containing multivitamins¹.

| | None ² | Insufficient ³ | Sufficient ⁴ | Exceeding ⁵ |
|-------------------------------|-------------------|---------------------------|-------------------------|------------------------|
| Recommended period* | | | | |
| Three months prior | 15 (25.9%) | 15 (25.9%) | 20 (34.5%) | 8 (13.8%) |
| First trimester | - | 4 (6.9%) | 40 (69.0%) | 14 (24.1%) |
| Non-recommended period | | | | |
| Second trimester | 22 (37.9%) | 16 (27.6%) | 12 (20.7%) | 8 (13.8%) |
| Third trimester | 34 (58.6%) | 12 (20.7%) | 7 (12.1%) | 5 (8.6%) |
| Six weeks post-partum | 38 (64.4%) | 15 (25.4%) | 5 (8.5%) | 1 (1.7%) |

¹n = 58 prior to and during and n = 50 postpartum (excludes participants who did not specify which multivitamin they took). ²None = 0 mg/week. ³Insufficient = 0.01-<32.5 mg/week. ⁴Sufficient = 32.5 mg/week. ⁵Exceeding = >32.5 mg/week (reported dose per day x reported average frequency of consumption per week. See methods for details of calculation).

*Recommended period = 4 weeks before becoming pregnant (three-month period before pregnancy was used as a surrogate for this time point) and the first 12 weeks of pregnancy (Ministry of Health, 2021).

Iodine supplement use

During the first, second and third trimester, approximately 50% of participants reported consuming the recommended amount of iodine and met the NZ MOH recommendation. During these time periods up to 28.4% of participants reported intakes greater than what is recommended. Iodine intake however, declined in the six-weeks post-partum with 37.4% of participants reportedly meeting the recommendation. During the non-recommended period, 42.8% of participants reported supplementing with iodine (Table 9).

Table 9. Proportion of women meeting New Zealand Ministry of Health recommendations based on average weekly iodine intake from both iodine-only tablet (150 µg) and iodine-containing multivitamins¹.

| | None ² | Insufficient ³ | Sufficient ⁴ | Exceeding ⁵ |
|-------------------------------|-------------------|---------------------------|-------------------------|------------------------|
| Non-recommended period | | | | |
| Three months prior | 312 (57.2%) | 74 (13.6%) | 65 (11.9%) | 94 (17.2%) |
| Recommended period* | | | | |
| First trimester | 36 (6.6%) | 74 (13.6%) | 280 (51.4%) | 155 (28.4%) |
| Second trimester | 40 (7.3%) | 94 (17.2%) | 279 (51.2%) | 132 (24.2%) |
| Third trimester | 57 (10.5%) | 96 (17.6%) | 272 (49.9%) | 120 (22.2%) |
| Six weeks post-partum | 209 (37.3%) | 117 (20.8%) | 210 (37.4%) | 25 (4.5%) |

¹n = 545 prior to and during pregnancy and n = 559 post-partum (excludes participants who did not specify which multivitamin they took). ²None = 0 µg/week. ³Insufficient = 0.01-<975 µg/week. ⁴Sufficient = 975 µg/week. ⁵Exceeding = >975 µg/week (reported dose per day x reported average frequency of consumption per week. See methods for details of calculation).

*Recommended period for iodine = during pregnancy and while breastfeeding (6 weeks post-partum was used as a surrogate for this time point) (Ministry of Health, 2020).

3.4.4. Socio-demographic and lifestyle determinants of sufficient supplement intake

Folic acid supplement intake

During the three months prior to pregnancy, when compared with the reference category, the odds of meeting or exceeding the NZ MOH recommended amount of FA were decreased for those who were not experiencing their first pregnancy, for women whose pregnancy was not planned and for those who occasionally and never used general supplements before pregnancy (OR: 0.34, 95% CI: 0.23-0.52, OR: 0.08, 95% CI: 0.03-0.23, OR: 0.47, 95% CI: 0.29-0.76, OR: 0.28, 95% CI: 0.17-0.47, respectively). Additionally, during this time period, when compared mothers from a household with a combined household income of less than \$100,000, the odds of supplementing with sufficient or excessive FA were increased for those with a combine household income of greater than \$150,000 (OR: 1.83, 95% CI: 1.02, 3.28). During the first trimester, the odds of meeting or exceeding the NZ MOH recommendation were decreased for women

who were not experiencing their first pregnancy when compared with women who were (OR: 0.48, 95% CI: 0.29-0.77).

Iodine supplement intake

During the NZ MOH recommended periods for iodine supplement use, the odds of meeting or exceeding the recommended amount of iodine were decreased for those who were not experiencing their first pregnancy compared to those that were (OR: 0.50, 95% CI: 0.31-0.80, OR: 0.54, 95% CI: 0.35-0.83, OR: 0.52, 95% CI: 0.34-0.79, and OR: 0.54, 95% CI: 0.37-0.78, respectively). Additionally, during the third trimester and post-partum period, when compared with those that regularly used general supplements before pregnancy, those who never used general supplements before pregnancy had decreased odds of meeting or exceeding the recommended amount of iodine (OR: 0.44, 95% CI: 0.26-0.74 and OR: 0.32, 95% CI: 0.20-0.50, respectively).

Table 10. The logistic regression of folic acid supplement intake, during the time periods recommended by the MOH¹, by socio-demographic and lifestyle determinants.

| Three months prior to pregnancy | | | | |
|---|----------------------------|--|---------------------------|-----------------------------|
| | None/insufficient n (%) | Meeting/exceeding the recommendation n (%) | Univariate OR (95% CI) | Multivariate OR (95% CI) |
| Age groups, years² | | | | |
| 18-25 | 148 (43.5) | 80 (39.0) | Reference category | |
| 26-35 | 151 (44.4) | 102 (49.8) | 1.25 (0.86, 1.81) | 1.25 (0.80, 1.97) |
| ≥36 | 41 (12.1) | 23 (11.2) | 1.04 (0.58, 1.85) | 1.04 (0.51, 2.14) |
| Ethnicity³ | | | | |
| NZ European | 290 (85.3) | 177 (86.8) | Reference category | |
| Others | 50 (14.7) | 27 (13.2) | 0.89 (0.53, 1.47) | 1.04 (0.57, 1.87) |
| Qualifications⁴ | | | | |
| Bachelor's degree and higher | 296 (87.1) | 192 (93.7) | Reference category | |
| Diploma/Polytechnic qualification/Trade certificate/Secondary School/None | 44 (12.9) | 13 (6.3) | 0.46 (0.24, 0.87)* | 0.54 (0.25, 1.14) |
| Total household income⁵ | | | | |
| <\$100,000 | 87 (26.1) | 28 (13.9) | Reference category | |
| >\$100,000 to <\$150,000 | 123 (36.9) | 71 (35.3) | 1.79 (1.07, 3.01)* | 1.46 (0.82, 2.62) |
| ≥\$150,000 | 123 (36.9) | 102 (50.7) | 2.58 (1.56, 4.25)* | 1.83 (1.02, 3.28)* |
| First pregnancy⁶ | | | | |
| Yes | 133 (39.1) | 134 (65.4) | Reference category | |
| No | 207 (60.9) | 71 (34.6) | 0.34 (0.24, 0.49)* | 0.34 (0.23, 0.52)* |
| Planned pregnancy⁷ | | | | |
| Yes | 256 (76.0) | 200 (97.6) | Reference category | |

| | | | | |
|---|----------------------------|--|---------------------------|-----------------------------|
| No | 81 (24.0) | 5 (2.4) | 0.08 (0.03, 0.20)* | 0.08 (0.03, 0.23)* |
| Supplement use before pregnancy ⁸ | | | | |
| Regularly used | 71 (20.9) | 91 (44.4) | Reference category | |
| Occasionally used | 130 (38.2) | 72 (35.1) | 0.43 (0.28, 0.66)* | 0.47 (0.29, 0.76)* |
| Never used | 139 (40.9) | 42 (20.5) | 0.24 (0.15, 0.38)* | 0.28 (0.17, 0.47)* |
| Self-reported maternal health before pregnancy ⁹ | | | | |
| Excellent | 210 (61.8) | 147 (71.7) | Reference category | |
| Good | 104 (30.6) | 47 (22.9) | 0.65 (0.43, 0.97)* | 0.89 (0.55, 1.43) |
| Fair/poor | 26 (7.6) | 11 (5.4) | 0.60 (0.29, 1.26) | 0.68 (0.30, 1.54) |
| First trimester | | | | |
| | None/insufficient n (%) | Meeting/exceeding the recommendation n (%) | Univariate OR (95% CI) | Multivariate OR (95% CI) |
| Age groups, years ² | | | | |
| 18-25 | 38 (37.3) | 190 (42.9) | Reference category | |
| 26-35 | 49 (48.0) | 240 (46.0) | 0.83 (0.52, 1.33) | 0.99 (0.59, 1.67) |
| ≥36 | 15 (14.7) | 49 (11.1) | 0.65 (0.33, 1.28) | 0.85 (0.41, 1.77) |
| Ethnicity ³ | | | | |
| NZ European | 84 (82.4) | 383 (86.7) | Reference category | |
| Others | 18 (17.6) | 59 (13.3) | 0.72 (0.40, 1.28) | 0.72 (0.39, 1.33) |
| Qualifications ⁴ | | | | |
| Bachelor's degree and higher | 88 (86.3) | 417 (90.5) | Reference category | |
| Diploma/Polytechnic qualification/Trade certificate/Secondary School/None | 14 (13.7) | 43 (9.7) | 0.68 (0.35, 1.29) | 0.64 (0.32, 1.26) |
| Total household income ⁵ | | | | |

| | | | | |
|---|-----------|------------|---------------------------|---------------------------|
| <\$100,000 | 20 (19.6) | 95 (22.0) | Reference category | |
| >\$100,000 to <\$150,000 | 37 (36.3) | 157 (36.3) | 0.89 (0.49, 1.63) | 0.74 (0.39, 1.40) |
| ≥\$150,000 | 45 (44.1) | 180 (41.7) | 0.84 (0.47, 1.51) | 0.62 (0.32, 1.20) |
| First pregnancy ⁶ | | | | |
| Yes | 34 (33.3) | 233 (52.6) | Reference category | |
| No | 68 (66.7) | 210 (47.4) | 0.45 (0.29, 0.71)* | 0.48 (0.29, 0.77)* |
| Planned pregnancy ⁷ | | | | |
| Yes | 78 (78.0) | 378 (85.5) | Reference category | |
| No | 22 (22.0) | 64 (14.5) | 0.60 (0.35, 1.03) | 0.67 (0.38, 1.20) |
| Supplement use before pregnancy ⁸ | | | | |
| Regularly used | 26 (25.5) | 136 (30.7) | Reference category | |
| Occasionally used | 40 (39.2) | 162 (36.6) | 0.77 (0.45, 1.33) | 0.83 (0.48, 1.46) |
| Never used | 36 (35.3) | 146 (32.7) | 0.88 (0.44, 1.34) | 0.93 (0.52, 1.67) |
| Self-reported maternal health before pregnancy ⁹ | | | | |
| Excellent | 61 (59.8) | 296 (66.8) | Reference category | |
| Good | 33 (32.4) | 118 (26.6) | 0.74 (0.46, 1.18) | 0.78 (0.47, 1.30) |
| Fair/poor | 8 (7.8) | 29 (6.5) | 0.75 (0.33, 1.71) | 0.70 (0.30, 1.65) |

OR-odds ratio; CI-confidence interval; *Statistically significant ($P<0.05$).

¹Recommended period = 4 weeks before becoming pregnant (three-month period before pregnancy was used as a surrogate for this time point) and the first 12 weeks of pregnancy (Ministry of Health, 2021). ²Maternal Age, n= 545 pre-pregnancy n=581 during pregnancy ³The main ethnicity group identified by women, n= 544 ⁴Maternal highest qualification, n= 545 pre-pregnancy n= 562 during pregnancy ⁵The total income from all sources of the household (before tax) over the last 12 months, n= 534 ⁶First time being pregnant, n= 545 ⁷This pregnancy was planned, n= 542 ⁸Frequency of dietary supplements used by women prior to this pregnancy, n= 545 pre-pregnancy n= 546 during pregnancy ⁹Maternal health status prior to this pregnancy, n= 545

Table 11. The logistic regression of iodine supplement intake, during the time periods recommended by the MOH¹, by socio-demographic and lifestyle determinants.

| First trimester | | | | |
|---|----------------------------|--|---------------------------|-----------------------------|
| | None/insufficient n (%) | Meeting/exceeding the recommendation n (%) | Univariate OR (95% CI) | Multivariate OR (95% CI) |
| Age groups, years ² | | | | |
| 18-25 | 39 (35.5) | 189 (43.4) | Reference category | |
| 26-35 | 60 (54.4) | 193 (44.4) | 0.66 (0.42, 1.04) | 0.77 (0.47, 1.28) |
| ≥36 | 11 (10.0) | 53 (12.2) | 0.99 (0.48, 2.07) | 1.38 (0.61, 3.13) |
| Ethnicity ³ | | | | |
| NZ European | 97 (88.2) | 370 (85.3) | Reference category | |
| Others | 13 (11.8) | 64 (14.7) | 1.29 (0.68, 2.44) | 1.34 (0.68, 2.64) |
| Qualifications ⁴ | | | | |
| Bachelor's degree and higher | 96 (87.3) | 392 (90.1) | Reference category | |
| Diploma/Polytechnic qualification/Trade certificate/Secondary School/None | 14 (12.7) | 43 (9.9) | 0.75 (0.40, 1.43) | 0.79 (0.40, 1.56) |
| Total household income ⁵ | | | | |
| <\$100,000 | 26 (23.9) | 89 (20.0) | Reference category | |
| >\$100,000 to <\$150,000 | 39 (35.8) | 155 (36.5) | 1.16 (0.66, 2.03) | 0.95 (0.52, 1.74) |
| ≥\$150,000 | 44 (40.4) | 181 (42.6) | 1.20 (0.70, 2.08) | 0.89 (0.48, 1.65) |
| First pregnancy ⁶ | | | | |
| Yes | 38 (34.5) | 229 (52.6) | Reference category | |
| No | 72 (65.6) | 206 (47.4) | 0.48 (0.31, 0.73)* | 0.50 (0.31, 0.80)* |
| Planned pregnancy ⁷ | | | | |
| Yes | 86 (80.4) | 370 (85.1) | Reference category | |
| No | 21 (19.6) | 65 (14.9) | 0.72 (0.42, 1.24) | 0.77 (0.43, 1.38) |

| | | | | |
|---|----------------------------|--|---------------------------|-----------------------------|
| Supplement use before pregnancy ⁸ | | | | |
| Regularly used | 22 (20.0) | 140 (32.2) | Reference category | |
| Occasionally used | 43 (39.1) | 159 (36.6) | 0.58 (0.33, 1.02) | 0.63 (0.35, 1.11) |
| Never used | 45 (40.9) | 136 (31.3) | 0.48 (0.27, 0.83)* | 0.56 (0.31, 1.01) |
| Self-reported maternal health before pregnancy ⁹ | | | | |
| Excellent | 67 (60.9) | 290 (66.7) | Reference category | |
| Good | 35 (31.8) | 116 (26.7) | 0.77 (0.48, 1.22) | 0.81 (0.49, 1.34) |
| Fair/poor | 8 (7.3) | 29 (6.7) | 0.84 (0.37, 1.91) | 0.76 (0.32, 1.80) |
| Second trimester | | | | |
| | None/insufficient n (%) | Meeting/exceeding the recommendation n (%) | Univariate OR (95% CI) | Multivariate OR (95% CI) |
| Age groups, years ² | | | | |
| 18-25 | 50 (37.3) | 178 (43.3) | Reference category | |
| 26-35 | 71 (53.0) | 182 (44.3) | 0.72 (0.48, 1.09) | 0.82 (0.51, 1.29) |
| ≥36 | 13 (9.7) | 51 (12.4) | 1.10 (0.56, 2.19) | 1.23 (0.59, 2.57) |
| Ethnicity ³ | | | | |
| NZ European | 116 (86.6) | 351 (85.6) | Reference category | |
| Others | 18 (13.4) | 59 (14.4) | 1.08 (0.61, 1.91) | 1.06 (0.58, 1.93) |
| Qualifications ⁴ | | | | |
| Bachelor's degree and higher | 115 (85.8) | 373 (90.8) | Reference category | |
| Diploma/Polytechnic qualification/Trade certificate/Secondary School/None | 19 (14.2) | 38 (9.2) | 0.62 (0.34, 1.11) | 0.60 (0.32, 1.11) |
| Total household income ⁵ | | | | |
| <\$100,000 | 29 (21.8) | 86 (21.4) | Reference category | |
| >\$100,000 to <\$150,000 | 51 (38.3) | 143 (35.7) | 0.95 (0.56, 1.60) | 0.81 (0.46, 1.43) |
| ≥\$150,000 | 53 (39.8) | 172 (42.9) | 1.09 (0.65, 1.84) | 0.86 (0.48, 1.54) |

| | | | | |
|---|----------------------------|--|---------------------------|-----------------------------|
| First pregnancy ⁶ | | | | |
| Yes | 48 (35.8) | 219 (53.3) | Reference category | |
| No | 86 (64.2) | 192 (46.7) | 0.49 (0.38, 0.73)* | 0.54 (0.35, 0.83)* |
| Planned pregnancy ⁷ | | | | |
| Yes | 107 (81.7) | 349 (84.9) | Reference category | |
| No | 24 (18.3) | 62 (15.1) | 0.79 (0.47, 1.33) | 0.84 (0.48, 1.46) |
| Supplement use before pregnancy ⁸ | | | | |
| Regularly used | 29 (21.6) | 133 (32.4) | Reference category | |
| Occasionally used | 51 (38.1) | 151 (36.7) | 0.65 (0.39, 1.08) | 0.66 (0.39, 1.12) |
| Never used | 54 (40.3) | 127 (30.9) | 0.51 (0.31, 0.86)* | 0.61 (0.36, 1.04) |
| Self-reported maternal health before pregnancy ⁹ | | | | |
| Excellent | 87 (64.9) | 270 (65.7) | Reference category | |
| Good | 38 (28.4) | 113 (27.5) | 0.96 (0.62, 1.49) | 1.09 (0.68, 1.76) |
| Fair/poor | 9 (6.7) | 28 (6.8) | 1.00 (0.46, 2.21) | 0.97 (0.43, 2.19) |
| Third trimester | | | | |
| | None/insufficient n (%) | Meeting/exceeding the recommendation n (%) | Univariate OR (95% CI) | Multivariate OR (95% CI) |
| Age groups, years ² | | | | |
| 18-25 | 58 (37.9) | 170 (43.4) | Reference category | |
| 26-35 | 79 (51.6) | 174 (44.4) | 0.75 (0.50, 1.12) | 0.81 (0.52, 1.27) |
| ≥36 | 16 (10.5) | 48 (12.2) | 1.02 (0.54, 1.94) | 1.12 (0.56, 2.25) |
| Ethnicity ³ | | | | |
| NZ European | 129 (84.3) | 338 (86.4) | Reference category | |
| Others | 24 (15.7) | 53 (13.6) | 0.84 (0.50, 1.42) | 0.81 (0.46, 1.40) |
| Qualifications ⁴ | | | | |
| Bachelor's degree and higher | 135 (88.2) | 353 (90.1) | Reference category | |

| | | | | |
|---|----------------------------|--|---------------------------|-----------------------------|
| Diploma/Polytechnic qualification/Trade certificate/Secondary School/None | 18 (11.8) | 39 (9.9) | 0.83 (0.46, 1.50) | 0.85 (0.45, 1.60) |
| Total household income ⁵ | | | | |
| <\$100,000 | 39 (25.2) | 77 (20.1) | Reference category | |
| >\$100,000 to <\$150,000 | 53 (35.1) | 141 (36.8) | 1.31 (0.80, 2.17) | 1.17 (0.68, 1.99) |
| ≥\$150,000 | 60 (39.7) | 165 (34.1) | 1.36 (0.83, 2.21) | 1.13 (0.66, 1.96) |
| First pregnancy ⁶ | | | | |
| Yes | 54 (35.3) | 213 (54.3) | Reference category | |
| No | 99 (64.7) | 179 (45.7) | 0.46 (0.31, 0.68)* | 0.52 (0.34, 0.79)* |
| Planned pregnancy ⁷ | | | | |
| Yes | 123 (82.0) | 333 (84.9) | Reference category | |
| No | 27 (18.0) | 59 (15.1) | 0.81 (0.49, 1.33) | 0.92 (0.54, 1.58) |
| Supplement use before pregnancy ⁸ | | | | |
| Regularly used | 31 (20.3) | 131 (33.4) | Reference category | |
| Occasionally used | 54 (35.3) | 148 (37.8) | 0.65 (0.39, 1.07) | 0.65 (0.39, 1.08) |
| Never used | 68 (44.4) | 113 (28.8) | 0.39 (0.24, 0.64)* | 0.44 (0.26, 0.74)* |
| Self-reported maternal health before pregnancy ⁹ | | | | |
| Excellent | 97 (63.4) | 260 (66.3) | Reference category | |
| Good | 46 (30.1) | 105 (26.8) | 0.85 (0.56, 1.29) | 0.97 (0.62, 1.53) |
| Fair/poor | 10 (6.5) | 27 (6.9) | 1.00 (0.47, 2.16) | 0.94 (0.43, 2.08) |
| Postpartum | | | | |
| | None/insufficient n (%) | Meeting/exceeding the recommendation n (%) | Univariate OR (95% CI) | Multivariate OR (95% CI) |
| Age groups, years ² | | | | |

| | | | | |
|---|------------|------------|---------------------------|---------------------------|
| 18-25 | 127 (44.1) | 105 (38.7) | Reference category | |
| 26-35 | 125 (43.4) | 133 (49.1) | 0.79 (0.54, 1.18) | 1.45 (0.96, 2.18) |
| ≥36 | 36 (12.5) | 33 (12.2) | 1.01 (0.55, 1.86) | 1.28 (0.69, 2.56) |
| Ethnicity ³ | | | | |
| NZ European | 245 (85.1) | 236 (87.4) | Reference category | |
| Others | 43 (14.9) | 34 (12.6) | 0.80 (0.48, 1.35) | 0.78 (0.46, 1.32) |
| Qualifications ⁴ | | | | |
| Bachelor's degree and higher | 262 (91.0) | 242 (89.3) | Reference category | |
| Diploma/Polytechnic qualification/Trade certificate/Secondary School/None | 26 (9.0) | 29 (10.7) | 0.88 (0.48, 1.60) | 1.36 (0.73, 2.51) |
| Total household income ⁵ | | | | |
| <\$100,000 | 69 (24.2) | 45 (17.2) | Reference category | |
| >\$100,000 to <\$150,000 | 97 (34.0) | 102 (38.9) | 1.49 (0.91, 2.45) | 1.50 (0.91, 2.47) |
| ≥\$150,000 | 119 (41.8) | 115 (43.9) | 1.44 (0.89, 2.32) | 1.23 (0.73, 2.04) |
| First pregnancy ⁶ | | | | |
| Yes | 119 (41.3) | 156 (57.6) | Reference category | |
| No | 169 (58.7) | 115 (42.4) | 0.47 (0.32, 0.68)* | 0.54 (0.37, 0.78)* |
| Planned pregnancy ⁷ | | | | |
| Yes | 232 (81.4) | 235 (86.7) | Reference category | |
| No | 53 (18.6) | 36 (13.3) | 0.88 (0.53, 1.44) | 0.79 (0.48, 1.31) |
| Supplement use before pregnancy ⁸ | | | | |
| Regularly used | 66 (22.9) | 101 (37.3) | Reference category | |
| Occasionally used | 97 (33.7) | 113 (41.7) | 0.72 (0.44, 1.17) | 0.77 (0.50, 1.19) |
| Never used | 125 (43.4) | 57 (21.0) | 0.41 (0.25, 0.66)* | 0.32 (0.20, 0.50)* |
| Self-reported maternal health before pregnancy ⁹ | | | | |
| Excellent | 193 (67.0) | 174 (64.2) | Reference category | |
| Good | 80 (27.8) | 75 (27.7) | 1.04 (0.71, 1.51) | 1.22 (0.81, 1.85) |

| | | | | |
|-----------|----------|----------|-------------------|-------------------|
| Fair/poor | 15 (5.2) | 22 (8.1) | 1.63 (0.82, 3.24) | 1.66 (0.79, 3.47) |
|-----------|----------|----------|-------------------|-------------------|

OR-odds ratio; CI-confidence interval; *Statistically significant ($P<0.05$).

¹Recommended period for iodine = during pregnancy and while breastfeeding (6 weeks post-partum was used as a surrogate for this time point) (Ministry of Health, 2020). ²Maternal Age, n= 545 during pregnancy n=559 post- pregnancy ³The main ethnicity group identified by women, n= 544 during pregnancy n= 558 post-pregnancy ⁴Maternal highest qualification, n= 545 during pregnancy n= 559 post-pregnancy ⁵The total income from all sources of the household (before tax) over the last 12 months, n= 534 during pregnancy n= 547 post-pregnancy ⁶First time being pregnant, n= 545 during pregnancy n= 559 post-pregnancy ⁷This pregnancy was planned, n= 542 during pregnancy n= 556 post-pregnancy ⁸Frequency of dietary supplements used by women prior to this pregnancy, n= 545 during pregnancy n= 559 post-pregnancy ⁹Maternal health status prior to this pregnancy, n= 545 during pregnancy n= 559 post-pregnancy

3.5. Discussion

To our knowledge, this was the first study in New Zealand to investigate both FA and iodine intake from supplements across pre, during and post-pregnancy time periods, detailing the supplements used by type(s) (single nutrient and/or MVT), and calculating the intake based on nutrient quantities, and the reported dose, duration, and frequency taken.

3.5.1. Folic acid

Of the women who participated in this study, 96.3% took a supplement containing FA at some point over the course of their pregnancy, which was very close to the percentages (96%) reported by Brown et al. (2020). During the three months before pregnancy just over half (57.6%) of participants were taking a supplement that contained FA (0.8 mg or 5mg), which was higher than what was reported by the GUiNZ study (39%) (Bulloch et al., 2019; Teixeira et al., 2018). One factor that had been identified as a predictor of whether a women takes FA during this period is whether the pregnancy is planned (Morton et al., 2013; Teixeira et al., 2018). In our study the planned pregnancy rate was higher (83.6%) than what was reported in GUiNZ (61.3%), and so may partly explain a higher rate of FA supplementation prior to pregnancy in the current study.

When looking at what women took in the three months before pregnancy, 30% reported taking a FA-only tablet, 18.3% taking a MVT and 9.5% reporting taking a FA-containing MVT in addition to a FA-only tablet. The remaining 42.4% reported taking no supplements containing FA. By dose, based on which strength of FA women reported they should be taking (i.e. 0.8 mg or 5 mg) around 30 % were taking a 'sufficient' dose, with 1 in 5 (0.8 mg dose) and 1 in 4 (5 mg dose) taking an insufficient dose. The low level of adherence to the MOH guideline during preconception in our study is concerning. The mandatory FA fortification of flour that commenced in August 2023, may be useful to increase the levels of FA intake in women during this preconception time.

Supplement use increased during the first trimester with 96.3% reportedly taking a FA-containing supplement. During this time period, the majority (60%) reported taking a

FA-only tablet, alongside this the number of women taking both FA-containing MVT and FA-only tablets also increased to 19.3%. The number of women who took sufficient FA during this period increased (62.2% 0.8 mg dose; 69% 5 mg dose), and more women exceeded (17.7% 0.8 mg dose; 24.1% 5 mg dose) than took an insufficient dose during this period.

In this study, 28 different FA-containing MVT were being taken by women before and during pregnancy in addition to the single nutrient FA (0.8 mg or 5 mg), only three (Elevit®, Full Circle Prenatal and the Prenatal Ease Pregnancy range) provided the exact dose of 0.8mg FA that is recommended by the NZ MOH for most NZ women. Thorne Basic Prenatal provided 1 mg FA per day and the remainder contained between 0.15 mg-0.6 mg per recommended dose. The low doses in some MVT likely contributed to a number of women being classified as taking an insufficient dose if they were taken alone, but conversely when taken alongside a FA single nutrient supplement meant some women were exceeding the dose, as was seen more in the first trimester.

A direct comparison with the SCOPE and GUINZ studies, as to how many participants took FA according to the MOH recommended guidelines, cannot be made as these studies only reported results for the complete period (at least 4 weeks prior to conception and during the first trimester). In the case of SCOPE this was 48% of participants and for GUINZ it only 7.6% of participants (Bulloch et al., 2019; Teixeira et al., 2018). Likewise, the SCOPE study only reported what women were taking at 15 weeks, reporting that 7.2% of women were taking more than the recommended dose (0.8 mg), and 79% were taking FA as part of or alongside a MVT (Bulloch et al., 2019).

During the second trimester and beyond (the non-recommended period for FA supplement use), over two-thirds (67.2%) of participants reported use of FA-containing supplements. Use did decrease as pregnancy progressed with only 37% of participants reporting FA-containing supplement during the post-partum period. The number during this period taking a single nutrient supplement decreased from 34.9 % to 10.9% while the number taking a MVT remained steady at around 20% and the number taking both also decreased.

Extended use, beyond the period recommended by the MOH, has also been reported by GUiNZ (56.7% of participants) and the SCOPE study which found that almost three-quarters (73%) of participants reported taking FA-containing supplements at 15 weeks' gestation (Bulloch et al., 2019; Teixeira et al., 2018). Brown et al. (2020) reported that 26% of their participants were still taking supplements containing FA while breastfeeding.

There is strong evidence to support taking FA preconception and during the first trimester (Berry et al., 1999; Medical Research Council, 1991; Werler et al., 1993). However, the same cannot be said for taking a higher dose and/or taking beyond the recommended time period with a number of studies indicating no benefit and even possible risks such for the infant such as increasing the risk of asthma (Yang et al., 2022).

It could be expected that extended use of FA-containing supplements would be driven largely by women taking MVT however, the reasoning for this extended use is unclear. Whether women are unaware that they are taking MVT containing FA or whether they believe extended use may be beneficial, in order to answer these questions some qualitative research is needed, alongside further research to better understand the possible risks and benefits are.

Almost 50% of the MVT taken by women were required to be taken more than once a day and so in order to be supplementing at these doses, participants must be following the instructions of the supplements. We noted that a number of women reported taking less than the directed amount (this is also true for iodine-containing MVT). There may be a few reasons for participants doing this, including to extend the use of the supplements, also taking a single nutrient preparation, being genuinely unaware of the instructions for use or being regularly forgetful to take another dose. These are, however, assumptions and further research into this behaviour would be required to understand contributing factors to this.

3.5.2. Factors associated with FA supplement use

As with previous NZ studies that have examined what factors might be associated with FA supplementation before pregnancy we found that decreased use was associated with a non-planned pregnancy, it not being the women's first pregnancy, and they never or only occasionally used supplements before pregnancy, while increased use was associated with having a combined household income of greater than \$150,000 (Mallard & Houghton, 2012; Morton et al., 2013; Teixeira et al., 2018; Wall et al., 2016). During the first trimester the only association that remained was that women whom this pregnancy was not their first were at decreased odds of meeting or exceeding the recommended intake of FA. This was unanticipated as it could be expected that this group of women would be more likely to be aware of the recommendation. However, a study in 2021, reported that women delivering their fourth or subsequent child were less likely to have received information about FA before conception and concluded that even when pregnancy was planned, some socio-demographic sub-groups were not being informed of the NZ MOH supplement recommendations (Mallard & Houghton, 2012). This is an important reminder, that LMC and other health professionals should not assume that women remember from one pregnancy to another what the recommendations are and that a reminder would be useful.

3.5.3. Iodine

Of the women who participated in this study, 93.4% took an iodine-containing supplement at some point of their pregnancy, which is very similar to the 95% of participants that was reported by Brown et al. (2020). At each trimester of pregnancy, over 90% of participants reported use of iodine-containing supplements, which is higher than previously reported in 2018 (84%, Reynolds et al.) and in 2011 (70%, Brough et al.). This may suggest more women are aware the MOH iodine recommendation introduced in 2010.

When taking into consideration average weekly iodine intake from both iodine-only tablets and iodine-containing MVT, at each trimester of pregnancy, only 50% were supplementing with a 'sufficient' dose (150 µg per day). Similarly, Reynolds and Skeaff

(2018) reported that 52% of their pregnant participants (n= 535) supplemented with at least 150 µg iodine per day, but the use of iodine supplements during the different time periods was not reported, and data on the actual dose and frequency of dose were not included. Such low level of adherence to the MOH recommendation of iodine supplementation during pregnancy has not been improved over the last five years, which requires attention.

Of the participants taking iodine-containing supplements during pregnancy, around 60% reported taking iodine-only tablets, 18% took an iodine-containing MVT and the remaining taking both. The percentage of participants taking no iodine during pregnancy incrementally increased over the three trimesters, from 6.6% to 10.5%. During pregnancy, around 25% of participants exceeded levels of recommended iodine supplementation during pregnancy. This is not unexpected, since 13-17% of participants took both an iodine-only tablet alongside an iodine-containing MVT, with 10 of the MVT being taken containing the recommended dose of 150 µg iodine per dose and 11 containing more than 150 µg iodine.

In our study, iodine supplement use decreased during the post-partum period to 75.7%, which was not surprising. Such reduction was also observed in Jin et al. (2021), Brown et al. (2020), and Brough et al. (2011). While single nutrient use declined to 49.7%, MVT use remained stable at 15.9% and usage of both dropped to 10%. The post-partum period is a busy and sometimes stressful period for mothers so there may be a number of contributing factors to this decline, although the most frequently reported reason for not taking iodine supplements was women were not advised to do so by a health professional (Jin et al. 2021). Further research would be valuable to further understand the barriers to iodine supplementation during this period.

The number of women who took 'sufficient' iodine during the post-partum period reduced to 37.4%, with 20.8% taking an insufficient dose. The few studies that have examined iodine supplementation while breast-feeding in NZ, have not analysed whether this has aligned with the MOH recommendations. Adequate supplementation of iodine contributes to adequate iodine intake for both mothers and their breastfed

infants, and such low adherence of iodine supplementation during this time period is a concern.

Prior to pregnancy, a period where iodine supplementation is not recommended by the NZ MOH, 43% of women reported taking iodine-containing supplements (15% as a single nutrient supplement, 21.2% as a MVT and the remainder taking both). However, the National Health and Medical Research Council of Australia has recommended iodine supplementation when planning pregnancy (NHMRC, 2010), since some evidence has suggested that adequate iodine intake (either from iodised salt or supplements) during the preconception period, maximises thyroid iodine stores and potentially decreases the changes in thyroid function and thyroid hormone production during pregnancy (Katko et al., 2018; Moleti et al., 2011; Moleti et al., 2008; Santiago et al., 2013). Further quality evidence may be required to confirm the benefits of using iodine supplementation during the preconception period.

3.5.4. Factors associated with iodine supplement use

The odds of having supplemented with iodine as recommended by the NZ MOH (timeframe and dose) were decreased for women who were not pregnant for the first time. This could be expected as women who are pregnant for the first time may be more careful, and more likely to actively seek information from health professionals, family or friends. No NZ studies have reported this association however, an Australian study conducted by Hine et al. (2018) reported similar findings where proportionally, more women who were pregnant for the first time, took iodine-containing supplements during pregnancy compared to those who were not. Another Australian study by Malek et al. (2016) observed a significant association with adherence to iodine supplementation guidelines and planned pregnancy however, this study did not find this association to be significant. Additionally, there were decreased odds of having met the recommended dose of 150 µg of iodine during the third trimester and during the six week post-partum period for women who never used general supplements prior to pregnancy. This association is a new finding that has not been reported in previous studies.

Examined sociodemographic factors did not show any statistically significant in predicting iodine supplementation. These results differ to what has been previously reported in NZ studies where low education status and low income have been associated with being less likely to have taken iodine supplements (Jin et al., 2021). This may be due to differences in the characteristics of study populations. Although in our study, we did not examine women's knowledge on iodine, in 2014, knowledge of iodine was identified to be associated with having taken iodine supplements. This may indicate that women are not receiving appropriate education of the importance of iodine intake around pregnancy and is an area that may benefit from further qualitative investigation (Mallard & Houghton, 2014).

3.5.5. Strengths and limitations

A strength of this study was that being online meant we could recruit a large number of participants from around the country. However, being online likely contributed to the sample not being as representative as it could be as those who participated were highly educated, predominantly of NZ European ethnicity, of good health and from high income households. Another limitation of this was that a number of participants had to be excluded because it was a self-reported questionnaire and so there was no ability to follow-up with participants.

3.6. Conclusion

As seen with other NZ studies, it is clear that many NZ women during the pregnancy period are not taking FA and iodine-containing supplements in a way that aligns with the MOH guidelines for these supplements. In addition to the single nutrient supplements, many women are taking a variety of different MVT supplements, and some are taking both. Many of the MVT available for purchase instore and online in NZ contain a large range of doses of FA and iodine, and in the case of FA, the majority do not meet the recommended 0.8 mg FA as recommended by the NZ MOH. This has resulted in a number of women reporting intakes of FA and iodine that were insufficient or exceeding the recommended doses. Although nearly all women took a FA or iodine

supplement at some stage during their pregnancy, there were some time periods where the increased numbers of women not taking the appropriate supplement was a concern, these were during the preconception period for FA and the post-partum period for iodine. This study has provided key insights in addition to the current research available in NZ, being the first large study in NZ that has investigated the frequency, duration and dose of supplement use before, during and after pregnancy. It has also highlighted more work needs to be done around translating the recommendations to women, there are areas that would benefit from qualitative research to understand why women are taking supplements the way that they are, and that it might be useful for LMC's to be aware of the range of MVTs that are available and the doses they contain.

Chapter 4: Conclusions and Future Recommendations

4.1. Study summary and achievements of aims and objectives

This cross-sectional observational study was undertaken to provide an updated insight into folic acid (FA) and iodine supplement use around pregnancy in New Zealand (NZ). Women (n= 584) from around NZ who were within six months post-partum were included in this study which took place between February and mid-August 2022. Women completed an anonymous, online questionnaire which collected data on overall supplement use before, during and after pregnancy as well as the socio-demographic characteristics of participants.

The primary aim of this study was to investigate what nutritional supplements containing FA and iodine and dosage of each were taken by postpartum New Zealand women, preconception, during the three trimesters of pregnancy and post-partum. This was accomplished by answering the following four objectives.

The first objective was to identify multivitamin (MVT) supplements that contain FA and iodine that are marketed towards pregnant and breastfeeding women in NZ and assess if the recommended daily doses of these supplements align with the Ministry of Health (MOH) recommendations. The 16 MVT that are available from mainstream pharmacies and online retailers in NZ contain a range of daily doses of FA (0.2 mg-0.8 mg) and iodine (37.5 µg-250 µg). Only one FA-containing MVT met the recommended 0.8 mg FA per day that is recommended to be taken by most women, whereas of those containing iodine, six contained 150 µg, meeting what is recommended by the MOH. The outcome from this audit informed questions in MVT section of the online questionnaire.

The second objective was to determine what nutritional supplements that contain FA and/or iodine are being taken by NZ women before, during the different stages of their pregnancy and women post-partum period (first six weeks following childbirth). Women reported the use of 28 different MVT containing FA and/or iodine before and during pregnancy and 26 different MVT after pregnancy, in addition to the single nutrient tablets subsidised by the NZ government (0.8 mg and 5 mg FA and 150 µg iodine). Of

the 28 MVT identified as being used at some point during pregnancy, 13 were those identified in the audit. Of the additional 15 MVT taken by women, six were general MVT supplements (not marketed for use during pregnancy) and the remaining nine were available to purchase from websites both in and outside of New Zealand, four of which were practitioner only and therefore, needed to be 'prescribed' by a Naturopath or similar. The most commonly used MVT was Elevit® with iodine, which contains 0.8 mg FA and 250 µg of iodine.

For FA, while most women indicated only taking the single nutrient tablets (0.8 mg or 5 mg) during the recommended period (preconception (30%) and first trimester (60.5%)), there were a number of women who took these in conjunction with a MVT, with the remainder who took FA taking a FA-containing MVT. In the first trimester only 3.7% of women took no FA. In the non-recommended period (post-first trimester) the number of women taking FA as a single supplement nutrient declined, but approximately one in five women continued to take it as part of a MVT.

During the recommended period for iodine supplementation around 60% reported only taking the single nutrient tablets during the three trimesters, with 18% taking an iodine-containing MVT and the remainder taking both. However, during the post-partum period, iodine-containing supplement use decreased with almost 25% of women reporting taking no supplements containing iodine, iodine-only supplement use decreased to almost 50% and iodine-containing MVT use remaining steady at almost 16%. In the non-recommended period (pre-conception) almost 60% of participants reported no iodine-containing supplement use, with over 20% taking an iodine-containing MVT and 15% taking an iodine-only supplement.

The third objective was to examine if their supplement use is aligned with the NZ MOH recommendations. During the MOH recommended period for FA supplementation, more than 60% of participants (including those taking a 5 mg dose) were supplementing with sufficient FA during the first trimester compared to around 30% in the three months prior to pregnancy. This was despite the high rates of planned pregnancy in this cohort with 84% of participants reporting their pregnancy was planned. During the first

trimester more women taking the lower dose of FA (0.8 mg) were not taking a sufficient dose compared to those women who had been recommended to take the higher dose (5 mg), but both strengths also had a significant number of women taking more than the recommended dose.

During the recommended period for iodine supplementation, the majority of women were meeting (approximately 50%) or exceeding (between 22 to 28%) the MOH recommendations during pregnancy, however this still left a significant number of women either taking no iodine supplement or taking an insufficient dose. The number taking a sufficient or exceeding dose dropped substantially during the six weeks post-partum.

We also noted not all women took their FA or iodine-containing supplements as directed, taking them less frequently or during periods where they are not recommended. This in conjunction with taking a MVT that may or may not contain the recommended levels of FA and/or iodine either instead of a single nutrient supplement or as well, led to many women either taking an insufficient dose or exceeding the recommended dose.

The final objective was to explore sociodemographic and lifestyle determinants of sufficient FA and/or iodine supplement intake. This study found that the odds of having a sufficient FA or iodine intake in line with what is recommended by the NZ MOH around pregnancy were significantly reduced if this pregnancy was not the mother's first and if women did not take supplements habitually before pregnancy. Additionally, sufficient FA use in the three months before pregnancy was significantly more likely in women from households with a combined household income of greater than \$150,000 and less likely if the pregnancy was unplanned.

4.2. Findings and conclusions

Findings from this study indicate that rates of supplement use around pregnancy in NZ women are high. There is a large range of supplements available for purchase in NZ that

are marketed towards women who are planning pregnancy, who are pregnant and who have recently given birth. As with other studies both here and in Australia more women are choosing to take a MVT supplement in addition to or instead of a single nutrient supplement (Brown et al., 2020; Hine et al., 2018; Jin et al., 2021; Teixeira et al., 2018). As a result, many women are continuing FA and iodine supplementation outside of the recommended periods and/or are exceeding the recommended dose if they are taking both a single nutrient tablet and a MVT or a MVT that contains a higher dose than is recommended. Further, we identified that some women (whether taking FA or iodine as single nutrient supplements or in a MVT or both) did not always take them at the instructed frequency, which may also contribute to women not meeting the NZ MOH recommendations.

Women were more likely to meet the NZ MOH recommended amounts of FA and iodine during the three trimesters of pregnancy rather than in the three months before (in the case of FA) and six weeks after (in the case of iodine). This may mean that the recommendations and health implications for FA supplement use before pregnancy need to be better communicated to women of child-bearing age so to capture those who fall pregnant unplanned. To ensure sufficient iodine supplement use during breastfeeding, health promotion initiatives are needed to those who are pregnant or health professionals who care for future mothers.

4.3. Impact

This study is one of the first in NZ to analyse both FA and iodine supplement use before, during and after pregnancy in relation to the NZ MOH recommendations. This research provides a unique insight into understanding if women are meeting the current recommendations and how they are doing so. It serves as a pilot study for further, more in-depth research to identify enablers and barriers for adequate supplement use and applying further qualitative examination in order to understand why women chose to supplement the way they do around pregnancy. Although several studies have examined FA intake by pregnant women in NZ, few studies have examined iodine intake. Further, it is important that regular studies are conducted to allow possible changes in

and barriers to supplement use to be identified, so that additional support may be provided where necessary to women of child-bearing age and/or their health professionals.

4.4. Strengths

One major strength was that we were able to utilise Qualtrics XM software to allow the questionnaire to be easily shared across multiple online communication platforms consequently reaching women throughout the whole of NZ quickly and effectively. A large sample of women were recruited in a short period of time which exceeded the designed sample size calculation.

Additionally, the design of the online questionnaire, with each section following a similar format meant it was relatively easy to complete, while still collecting a wide range of data. A mixture of open and closed ended questions were utilised with multiple choice answers and the option to skip some questions (if it was not relevant) were provided for many questions, as a way to reduce participant burden and increase questionnaire completion. The anonymous nature of this online questionnaire also reduces participant bias.

By completing an audit of what MVT supplements are available and were being taken, it was possible to identify which ones, if taken correctly, would allow a woman to meet the current MOH recommendations for FA and iodine, as an alternative to taking separate single FA and iodine supplements. Additionally, the audit informed two questions within the MVT section of the questionnaire that utilised images of the identified supplements to provide precise answer options and act as a reminder to the participant.

4.5. Limitations

Women who did not have access to the internet or the limited ability to use a device to visit online platforms were not exposed to the study information and subsequently were not able to take part in the study. Additionally, those not proficient in reading English

were also unable to take part in this research as the questionnaire was only available in English.

Women who participated in the study were predominantly NZ European/Pakeha, highly educated, from households of higher income earners and self-reported excellent health prior to pregnancy. This has resulted in the study population not being representative of the general NZ population despite a large sample size, meaning results cannot be extrapolated to the general population.

Participants were unable to be contacted retrospectively to completing the questionnaire, which meant a number of responses were excluded from the analysis as there was no ability to reach out to participants to clarify answers that were incomplete or unrealistic. Likewise, once participants had started the questionnaire, they were not able to have anything clarified. As the study was self-administered, the study relied on participants correct understanding and interpretation of the questions.

In an effort to reduce the participant burden, only limited socio-demographic factors were asked. This resulted in less factors being examined when compared with other similar studies.

As participants were recruited at least six weeks following birth this introduced the limitation of recall bias. Participants were asked to recall and report their supplement habits from 12-18 months prior to completing the questionnaire which may reduce the accuracy of answers reported by participants.

4.6. Recommendations for future research

To reduce the recall bias and gain more accurate data on supplementation habits, it may be beneficial to recruit women at the beginning of their pregnancy, and follow them up to their postpartum period, by asking them to complete a questionnaire at the end of each stage (three months prior to pregnancy, each trimester and six weeks postpartum).

To increase the variation in demographic characteristics of participants, it may be advantageous to offer the questionnaire in other forms such as paper copies available for those who may not have access to a computer and/or internet. It would also be beneficial to liaise with relevant advisors to develop recruitment strategies for further research that explores supplement usage among Māori, Pacific and other minority groups or populations who are less educated or low-income families.

This study has briefly discussed how women are taking supplements however, further qualitative research into the motivational and behavioural factors behind supplement intake during this time would prove valuable to understand how to better support women around pregnancy to ensure they are meeting the NZ MOH recommendations. This could also be extended to clinical health professionals' knowledge.

Additional research into the other nutrients of concern during pregnancy such as iron, vitamin D and vitamin B12, that are recommended by the NZ MOH among at-risk populations, would also be beneficial to understand whether these recommendations are being followed as well.

4.7. Recommendations for clinical practice

As there are more and more MVT available on the market advertised towards pregnant women it may also be beneficial to develop a guidance tool for practitioners with a breakdown of the ingredients within these MVT and whether they provide FA and iodine in alignment with the NZ MOH recommendations. A quick and easy tool that practitioners can use to identify whether women are taking the recommended dose of these nutrients and guide/recommend alternatives if they are taking insufficient amounts.

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Appendices

Appendix A: Supplementary results

1. Supplement audit

| Product (Brand) | Nutrient | Price per cap (\$) | Cost of recommended dose/day (folic acid [0.8mg] and iodine[150µg]) | Dose | Amount of nutrient per dosage (information shown on label) or as described on website) | When is it recommended to take |
|---|-----------|--------------------|---|---------------------------------|--|---|
| Blackmores Conceive Well Gold Capsules + Tablets | Multi vit | 0.57 | Folic acid: 0.91, contains 62.5% of recommended daily dose Iodine: 0.57, contains 100% of recommended daily dose | 1 cap and 1 tab daily with food | Tablet: 150µg Iodine 500µg Folic Acid 1.3mg Copper 1.5mg B2 1.5mg B1 5mg Manganese 15mg Zinc 20mg Nicotinamide 24mg Iron 50mg B6 200mg Magnesium 200mg Ascorbic acid 363mg Calcium ascorbate dihydrate 65µg Selenium 100µg Biotin | Ideally taken up to 6 months before conception. Once pregnant recommended to switch to Blackmores Pregnancy and Breastfeeding Gold. |

| | | | | | | |
|----------------------------|-----------|------|---|-------------|--|---|
| | | | | | <p>4.6mg B5 50µg B12</p> <p>Tab: 500mg fish oil 200IU Vit E 60mg Coenzyme Q10 10µg Cholecalciferol 1.5mg Betacarotene</p> | |
| Elevit with Iodine | Multi vit | 0.79 | <p>Folic acid: 0.79, contains 100% of recommended daily dose</p> <p>Iodine: 0.47, contains 167% of recommended daily dose</p> | 1 tab daily | <p>800µg Folic Acid</p> <p>1.55mg B1 19mg B3 10mg B5 2.6mg B6 4µg B12 100mg Vit C 500IU D3 15mg Vit E 200µg Vit H 60mg Iron 250µg Iodine</p> <p>125mg Calcium 100mg Magnesium 125mg Phosphorus 1mg Copper 1mg Manganese 7.5mg Zinc</p> | Suggested to take for at least a month before first planning on getting pregnant and then throughout pregnancy and breast feeding |
| Forever Mum – Her Conceive | Multi vit | 0.89 | <p>Folic acid: 1.42, contains 62.5% of</p> | 1 cap daily | <p>500µg Folic Acid</p> <p>5mg Zinc 60µg Selenium</p> | Once you conceive its recommended to switch to forever mum pre- |

| | | | | | | |
|---|-----------|------|---|-------------|---|--|
| | | | recommended daily dose Iodine: 0.89, contains 100% of recommended daily dose | | 150µg Iodine 110mg Choline 1.135mg B1 1.4mg B2 18mg B3 5mg B5 50mg B6 10µg Mecobalamin 200mg Ascorbic acids 5mg Iron | conception and pregnancy multivitamin |
| Forever Mum – Preconception + Pregnancy Multi | Multi vit | 0.66 | Folic acid: 1.06, contains 62.5% of recommended daily dose Iodine: 0.66, contains 100% of recommended daily dose | 1 cap daily | 500µg folic acid 150µg Iodine 5mg Iron 1.4mg B2 18mg B3 2.5mg B5 1mg B6 1.3µg Mecobalamin 30µg B7 60mg Ascorbic acid 30µg Menaquinone 50mg Choline 5.3IU Vit E 5µg Cholecalciferol 2.4mg Betacarotene 50mg Calcium 30µg Chromium 800µg Manganese 16.25µg Selenium 5mg Zinc | Specifically formulated to support mum’s maternal health and baby’s foetal health development during pregnancy |

| | | | | | | |
|---|-----------|------|---|--------------------------|---|---|
| | | | | | 33.3µg Molybdenum 700µg B1 | |
| Healthieries Pregnancy and Breastfeeding Multi | Multi vit | 0.31 | Folic acid: 0.83, contains 37.5% of recommended daily dose Iodine: 0.19, contains 167% of recommended daily dose | 1 cap daily with food | 2mg B1 2mg B2 22mg B3 12mg B5 4mg B6 300µg Folic acid 50µg B12 100µg B7 3mg Betacarotene 60mg Ascorbic acid 17.5µg Cholecalciferol 12IU Vit E 40mg Calcium 10mg Choline 30µg Chromium 10mg Iron 1mg Copper 500µg Manganese 10mg Zinc 2mg Potassium 250µg Iodine 65µg Selenium 100mg Magnesium | Take for at least 1 month prior to conception |
| Radiance Preconception and Pregnancy Multi | Multi vit | 0.33 | Folic acid: 1.67, contains 18.75% of recommended daily dose | 1 tab daily with food | 15mg B1 15mg B2 15mg B3 15mg B5 15mg B6 | To help support optimal nutrition status during preconception, pregnancy and lactation |

| | | | | | | |
|---------------------------|-----------|------|---|-------------------------------------|---|--|
| | | | Iodine: 0.66, contains 50% of recommended daily dose | | 25µg B12 100mg Vit C 500IU Vit D 50IU Vit E 50µg Vit K1 1.5mg Betacarotene 30mg Bioflavonoids 50µg Biotin (B7) 5mg Choline 250µg Folic Acid 5mg Inositol 500µg PABA 500µg Boron 300mg Calcium 25µg Chromium 1mg Copper 10mg Iron 50µg Iodine 150mg Magnesium 1mg Manganese 20µg Molybdenum 24mg Phosphorus 10mg Potassium 20µg Selenium 11mg Silica 5µg Vanadium 7.5mg Zinc | |
| Solgar Prenatal Nutrients | Multi vit | 0.25 | Folic acid: 1, contains 25% of | 1 tab daily, preferably at mealtime | Calcium 326mg Magnesium 113.5mg Soy Protein Isolate 20mg | For women before, during and after pregnancy |

| | | | | | | |
|---|-----------|------|---|---|---|--|
| | | | <p>recommended daily dose</p> <p>Iodine: 1, contains 25% of recommended daily dose</p> | | <p>Iron 7mg Vit C 25mg Betacarotene 0.9mg Providing other carotenoids 2.4ug Biotin 75ug Vitamin E 5mg Zinc 3.75mg Vit B3 5mg L-Aspartic Acid 5mg Glycine 5mg Copper 0.5mg B5 2.5mg Manganese 0.25mg Inositol 2.5mg Choline 1mg Vitamin D 2.5ug Folic acid 200ug Selenium 6.25ug Iodine 37.5ug Vitamin B6 0.675mg B1 0.425mg B2 0.5mg Vitamin B12 2ug Chromium 6.25ug</p> | |
| Swisse Ultinatal Preconception and Pregnancy multivitamin | Multi vit | 0.28 | Folic acid: 1.12, contains 25% of recommended daily dose | 2 cap daily, during or immediately after a meal | <p>5-Methylfolate 100 µg Folic Acid 400 µg Methyl B12 1.31 µg Choline 22.62 mg</p> | Supports increased nutritional needs of women before, during and after pregnancy including breastfeeding |

| | | | | | | |
|--|-----------|------|--|-----------------------------------|--|---|
| | | | Iodine: 0.38, contains 73.3% of recommended daily dose | | Concentrated Fish Omega-3 Triglycerides 250 mg Biotin 15 µg Vitamin B1 700 µg Vitamin B2 700 µg Vitamin B3 9 mg Vitamin B5 2.5 mg Vitamin B6 950 µg Vitamin C 30 mg Vitamin D3 500 IU Vitamin E 5.22 IU Calcium 25 mg Iodine 220 µg Iron 5 mg Magnesium 25 mg Selenium 32.5 µg Zinc 5.50 mg | |
| Vitawomenz Conception and Pregnancy Support | Multi vit | 0.75 | Folic acid: 1.2, contains 62.5% of recommended daily dose Iodine: 0.56, contains 133% of recommended daily dose | 1 cap daily, preferably with food | Folic Acid 500 µg Iodine 200 µg Iron 20 mg Omega 3 300 mg Vitamin D 10 µg Vitamin E 20 mg Vitamin K 70 µg Vitamin C 100 mg Vitamin B1 1.5 mg Vitamin B2 2 mg Vitamin B3 20 mg Vitamin B 5 10 mg Vitamin B12 6 µg | Supports female health from preconception through till the end of pregnancy |

| | | | | | | |
|--|-----------|------|---|---------------------------|--|---|
| | | | | | Biotin (Vit H) 150 µg Magnesium 150 mg Zinc 15 mg Copper 1000 µg Selenium 30 µg | |
| Blackmores Pregnancy and Breastfeeding Gold | Multi vit | 0.24 | Folic acid: 0.38, contains 62.5% of recommended daily dose Iodine: 0.24, contains 100% of recommended daily dose | 2 cap daily with meals | 2 cap dose contains: 500mg Fish oil 1400µg B1 1400µg B2 18mg B3 1900µg B6 2.6µg B12 500µg Folic acid 60mg Ascorbic acid 18µg Cholecalciferol 10.44IU Vit E 5mg B5 30µg B7 4.8mg Betacarotene 100mg Calcium 30µg Chromium 65µg Selenium 70mg Magnesium 10mg Iron 11mg Zinc 150µg Iodine | Take during and after pregnancy, while breastfeeding |
| Elevit Breastfeeding | Multi vit | 0.66 | Folic acid: 1.06, contains 62.5% of | 1 cap daily | Lutein 250mcg Concentrated Omega- 3 425.6mg Betacarotene 6.5mg | After baby is born, switch from Elevit for pregnancy to Elevit Breastfeeding to |

| | | | | | | |
|--|-----------|------|---|-------------|---|---|
| | | | recommended daily dose Iodine: 0.44, contains 150% of recommended daily dose | | Folic acid 500µg Iron 9mg Iodine 225mcg Vitamin B1 1.4mg Vitamin B2 1.6mg Vitamin B3 17mg Vitamin B5 7mg Vitamin B6 2mg Vitamin B12 2.8mcg Vitamin C 60mg Vitamin D3 600IU Vitamin E 10 mg Vitamin H (Biotin) 35mcg Calcium 120mg Zinc 10mg Selenium 55mcg | support nutritional needs during this time |
| GO Healthy GO Pregnancy and Breastfeeding Advance | Multi vit | 0.41 | Folic acid: 1.31, contains 31.25% of recommended daily dose Iodine: 0.73, contains 0.56% of recommended daily dose | 2 cap daily | Concentrated Fish Omega-3 triglycerides 600mg ThiaBeta-carotene 3mg Vitamin B1 4mg Vitamin B2 4mg Vitamin B3 9mg Vitamin B5 4mg Vitamin B6 3.2mg Vitamin B12 1.5µg Folic Acid 250µg Biotin 15µg Vitamin C 45mg Colecalciferol 12.5µg Vitamin E 30IU | Support for preconception, during and after pregnancy while breastfeeding |

| | | | | | | |
|--|----------|------|---|-------------|--|--|
| | | | | | Calcium 50mg Chromium 15.5µg Copper 168µg Iron 5mg Magnesium 35mg Iodine 84µg Selenium 75µg Zinc 10mg | |
| Microgenics pregnancy support multivitamin | Multivit | 0.05 | Folic acid: 0.08, contains 62.5% of recommended daily dose Iodine: 0.03, contains 167% of recommended daily dose | 1 cap daily | Concentrated fish Omega-3 triglycerides 500mg Betacarotene 5mg Thiamine hydrochloride 5mg Riboflavin (Vitamin B2) 5mg Nicotinamide 20mg Calcium pantothenate 10mg Pyridoxine hydrochloride 50mg Equiv. to Pyridoxine (Vitamin B6) 41.13mg Folic Acid 500µg Ascorbic acid (Vitamin C) 62mg Colecalciferol (Vitamin D3 200IU) 5µg Calcium 20mg Chromium 2.5micrograms Iron 5mg Magnesium 10mg Manganese 1mg Iodine 250µg | Recommended at least 4 weeks before conception and during the first trimester to help support foetal development |

| | | | | | | |
|------------------|-----------|------|---|-------------------------------|---|--|
| | | | | | Selenium 16.25µg Silicon 4.67mg Zinc 12mg | |
| BePure Mum's One | Multi vit | 0.77 | Folic acid: 2.05, contains 37.5% of recommended daily dose Iodine: 0.77, contains 100% of recommended daily dose | 3 cap per day taken with food | Every 3 capsules provides: 1000IU Vit A as beta-carotene 1000IU of Vit A as Retinyl Acetate 20mg B1 20mg B2 30mg B3 40mg B5 20mg B6 as Pyridoxine HCl 20mg B6 as Pyridoxal 5' Phosphate 300µg B7 300µg B9 50g B12 150mg Vit C 1000IU Vit D 75mg Vit E 120µg Vit K2 1mg Boron 150mg Betaine Anhydrous 50mg Calcium 450mg Choline 29µg Chromium 2mg Copper 150µg Iodine 20mg Iron 150µg Kelp trace elements | Designed to support your body and baby when preparing for pregnancy, during pregnancy and keeping you nourished post pregnancy whilst breastfeeding. |

| | | | | | | |
|-----------------------|----------|------|--|-------------|---|---|
| | | | | | 100mg magnesium 2mg Manganese 50µg Molybdenum 150µg Selenium 5mg Silica 75µg Vanadium 15mg Zinc | |
| BePure Folate Restore | Folate | 1.3 | Folic acid: 2.08, contains 62.5% of recommended daily dose Iodine: 1.95, contains 66.7% of recommended daily dose | 1 cap daily | 250µg methylated folate 250µg folic acid 100µg iodine | BePure Folate Restore has been designed to support healthy folate levels in the body, particularly for women prior to conception, during pregnancy, and postpartum. |
| Fabfol tablets | Multivit | 0.45 | Folic acid: 0.72, contains 62.5% of recommended daily dose Iodine: 0.45, contains 100% of recommended daily dose | 1 tab daily | Iron 12mg Magnesium 50mg Zinc 1.5mg Iodine 150µg Folic Acid 500µg Vitamin B1 1.5mg Vitamin B2 1.5mg Vitamin B3 7.5mg Vitamin B6 1.5mg Vitamin B12 4µg Vitamin C 100mg Vitamin D3 5µg | FABFOL is specially formulated to help meet the additional vitamin and mineral needs during preconception, pregnancy and breastfeeding. |

Yellow = pharmacy direct, accessed 22/09/21
Green = chemist warehouse, accessed 28/09/21
Pink = google, accessed 28/09/21
Blue = folic acid
Red = Iodine

2. Table of reported multivitamins being taken

| Multivitamins taken before and during pregnancy | FA/tab | Iodine/tab | Dose/day | FA/dosage | Iodine/dosage | Taken by |
|---|--------|------------|----------|-----------|---------------|----------|
| Elevit with Iodine | 0.8 | 250 | 1 | 0.8 | 250 | 92 |
| Elevit Breastfeeding | 0.5 | 225 | 1 | 0.5 | 225 | 1 |
| GO Healthy GO Pregnancy and Breastfeeding | 0.125 | 42 | 2 | 0.25 | 84 | 3 |
| Radiance Preconception and Pregnancy Multi | 0.125 | 25 | 2 | 0.25 | 50 | 2 |
| Microgenics pregnancy support | 0.5 | 250 | 1 | 0.5 | 250 | 1 |
| BePure Mum's One | 0.1 | 50 | 3 | 0.3 | 150 | 14 |
| Blackmores Pregnancy and Breastfeeding Gold | 0.25 | 75 | 2 | 0.5 | 150 | 47 |
| BePure Folate Restore | 0.5 | 100 | 1 | 0.5 | 100 | 1 |
| Swisse Ultinatal Preconception and Pregnancy multivitamin | 0.25 | 110 | 2 | 0.5 | 220 | 8 |
| Forever Mum – Preconception + Pregnancy Multi | 0.5 | 150 | 1 | 0.5 | 150 | 4 |
| Healtheries Pregnancy and Breastfeeding Multi | 0.3 | 250 | 1 | 0.3 | 250 | 10 |
| Solgar Prenatal Nutrients | 0.2 | 37.5 | 1 | 0.2 | 37.5 | 3 |
| Blackmores Conceive Well Gold Capsules + Tablets | 0.5 | 150 | 1 | 0.5 | 150 | 3 |
| Healtheries womens multivit | 0.2 | 150 | 1 | 0.2 | 150 | 2 |
| Health by habit womens multi | 0.237 | 68.9 | 1 | 0.237 | 68.9 | 1 |
| Thorne basic prenatal | 0.33 | 50 | 3 | 1.0 | 150 | 2 |
| Metagenics pregnancy care advanced | 0.2 | 149.5 | 2 | 0.4 | 299 | 5 |
| Orthoplex pure natal | 0.5 | 270 | 1 | 0.5 | 270 | 3 |

| | | | | | | |
|--------------------------------------|-------|-----|---|------|-----|-----|
| Blackmores womens multivitamin | 0.4 | 150 | 1 | 0.4 | 150 | 1 |
| Eagle tresos natal | 0.5 | 270 | 1 | 0.5 | 270 | 13 |
| BePure one | 0.06 | 30 | 5 | 0.3 | 150 | 2 |
| Naturo best | 0.25 | 135 | 2 | 0.5 | 270 | 1 |
| Usana prenatal vitamins and minerals | 0.15 | 70 | 4 | 0.6 | 280 | 1 |
| Berocca | 0.15 | 0 | 1 | 0.15 | 0 | 1 |
| Vitabiotics pregnacare max | 0.2 | 75 | 2 | 0.4 | 150 | 1 |
| Centrum for women | 0.4 | 150 | 1 | 0.4 | 150 | 1 |
| BioMedica natal care | 0.125 | 70 | 2 | 0.25 | 140 | 1 |
| Prenatal Ease | 0.4 | 110 | 2 | 0.8 | 220 | 1 |
| Total | | | | | | 230 |

| Multivitamins taken post-partum | FA/tab | Iodine/tab | Dose/day | FA/dosage | Iodine/dosage | Taken by |
|---|--------|------------|----------|-----------|---------------|----------|
| Elevit with Iodine | 0.8 | 250 | 1 | 0.8 | 250 | 30 |
| Elevit Breastfeeding | 0.5 | 225 | 1 | 0.5 | 225 | 13 |
| GO Healthy GO Pregnancy and Breastfeeding | 0.125 | 42 | 2 | 0.25 | 84 | 1 |
| The Good Vitamin Co | 0.144 | 22.2 | 2 | 0.28 | 44.4 | 1 |
| Naturo best | 0.25 | 135 | 2 | 0.5 | 270 | 2 |
| Me today | 0.3 | 50 | 1 | 0.3 | 50 | 1 |
| Blackmores Pregnancy and Breastfeeding Gold | 0.25 | 75 | 2 | 0.5 | 150 | 46 |
| BePure Mum's One | 0.1 | 50 | 3 | 0.3 | 150 | 12 |
| BePure Folate Restore | 0.5 | 100 | 1 | 0.5 | 100 | 1 |
| Swisse Ultinatal Preconception and Pregnancy multivitamin | 0.25 | 110 | 2 | 0.5 | 220 | 2 |
| Forever Mum – Preconception + Pregnancy Multi | 0.5 | 150 | 1 | 0.5 | 150 | 1 |
| Healtheries Pregnancy and Breastfeeding Multi | 0.3 | 250 | 1 | 0.3 | 250 | 3 |
| Solgar Prenatal Nutrients | 0.2 | 37.5 | 1 | 0.2 | 37.5 | 4 |

| | | | | | | |
|--|-------|-------|---|------|-----|-----|
| Blackmores Conceive Well Gold Capsules + Tablets | 0.5 | 150 | 1 | 0.5 | 150 | 1 |
| Metagenics pregnancy care advanced | 0.2 | 149.5 | 2 | 0.4 | 299 | 2 |
| Orthoplex pure natal | 0.5 | 270 | 1 | 0.5 | 270 | 4 |
| BePure one | 0.06 | 50 | 5 | 0.3 | 250 | 1 |
| Berocca | 0.15 | 0 | 1 | 0.15 | 0 | 2 |
| Vitabiotics pregnacare max | 0.2 | 75 | 2 | 0.4 | 150 | 1 |
| Eagle tresos natal | 0.5 | 270 | 1 | 0.5 | 270 | 10 |
| Healtheries womens multivit | 0.2 | 150 | 1 | 0.2 | 150 | 3 |
| Blackmores womens multivitamin | 0.4 | 150 | 1 | 0.4 | 150 | 1 |
| Centrum for women | 0.4 | 150 | 1 | 0.4 | 150 | 1 |
| Thorne basic prenatal | 0.33 | 50 | 3 | 1.0 | 150 | 2 |
| Usana prenatal vitamins and minerals | 0.15 | 70 | 4 | 0.6 | 280 | 1 |
| BioMedica natal care | 0.125 | 70 | 2 | 0.25 | 140 | 1 |
| Total | | | | | | 147 |

3. Variable table for logistic regression analysis

| Variables | Description | Definition |
|--|--|---|
| Dependent variable | | |
| Supplement use | None or sufficient Sufficient or exceeding | Supplement use compared to the MOH guidelines |
| Covariates | | |
| Age | Reference category – 18-25yrs 1 – 26-35yrs 2 – ≥36yrs | Maternal age |
| Ethnicity | Reference category – NZ European 1 – Others | The main ethnicity group identified by women |
| Qualification | Reference category – Bachelor’s degree and higher 1 – Diploma/Polytechnic qualification/Trade certificate/Secondary School/None | Maternal highest qualification |
| Household income | Reference category - <\$100,000 1 – >\$100,000 to <\$150,000 2 – ≥\$150,000 | The total income from all sources of the household (before tax) over the last 12 months |
| First pregnancy | Reference category – Yes 1 – No | First time being pregnant |
| Planned pregnancy | Reference category – Yes 1 – No | This pregnancy was planned |
| Supplement use before pregnancy | Reference category – Regularly used 1 – Occasionally used 2 – Never used | Frequency of dietary supplements used by women prior to this pregnancy |
| Self-reported maternal health before pregnancy | Reference category – Excellent 1 – Good 2 – Fair/poor | Maternal health status prior to this pregnancy |

Appendix B: Study posters



Massey University's College of Health are conducting an online survey to explore what supplements women are taking before, during and after their pregnancy.

WHO ARE WE LOOKING FOR?

- Women aged 18 years or older living in New Zealand,
- and are in the later stages of their pregnancy or have recently given birth
- became pregnant without using assisted reproductive technologies (such as in-vitro fertilisation)
- and are able to complete the survey online in English

If this sounds like you or a friend scan me for the survey!



https://massey.au1.qualtrics.com/jfe/form/SV_7aJFfTI0J7J4ntQ

Or get in contact:
b.hunter@massey.ac.nz



Participants Needed

HAVE YOU HAD A
BABY THIS YEAR?

I really need some more
people to complete my
short online survey about
supplement use around
pregnancy

Click the link to be taken to the survey!

This project has been evaluated by peer review and judged to be low risk. Consequently, it has not been reviewed by one of the University's Human Ethics Committees. The researcher(s) are responsible for the ethical conduct of this research.



Appendix C: Study information sheet

INFORMATION SHEET

Dietary supplement use before, during and after pregnancy

Invitation to Participate in the Research Study

My name is Brianna Hunter, and I am a postgraduate student undertaking a thesis project to complete a Master of Science degree in Nutrition and Dietetics at Massey University. I am under the supervision of Dr Cheryl Gammon and Dr Ying Jin from the School of Health Sciences at Massey University.

Please read this Information Sheet carefully before deciding whether you wish to take part in our study. You are under no obligation to participate in this study. Feel free to discuss with your family, whānau, and friends.

Project Description

Pregnancy and breastfeeding places additional nutrient demand on a woman's body. Most women will receive advice from their lead maternity carer (LMC) on diet and possible use of dietary supplements (including preparations such as folic acid, iodine and iron) during the different stages of pregnancy or after childbirth. The LMC can prescribe these individual dietary supplements, with the prescription then filled by a Pharmacy. In addition, there is an increasing number of mainly multivitamin dietary supplements aimed at pregnant and breastfeeding women, which are available online and in a range of shops. At the same time, women are being exposed to a wider range of sources of information than ever before, such as the internet (health websites, Facebook), TV and other media (radio, newspapers, magazines), other health professionals such as Pharmacists, and friends and family.

The study will involve an online questionnaire for mothers with newborns to explore what supplements they took before becoming pregnant, during the three trimesters of pregnancy, and the period following the birth of their child.

Participant Identification and Recruitment

We aim to recruit 300 participants for this study.

To participate in this study, you must:

- be female
- ≥ 18 years old
- reside in New Zealand
- be in the later stages of your pregnancy or have given birth within the last 3 months
- not have used any assisted reproductive technologies (such as *in-vitro* Fertilisation) to become pregnant due to increased specialist advice
- be proficient in English and able to complete an online questionnaire

What does the study involve?

Prospective participants will be invited to take part in the online survey via an anonymous link. There will be the opportunity to read the description of the study including a section on data confidentiality, before completing several screening questions to confirm their eligibility to take part in the study. If eligible, participants will need to acknowledge that by agreeing to continue, they are consenting to be included in this part of the research and be directed to start the survey. Once the survey is completed, participants will receive an automated message of survey completion and be provided with details as to where they will be able to find a summary of the results.

The online questionnaire will take approximately 15 minutes.

What are the benefits of taking part in this study?

This study will help to fill the knowledge gap on what dietary supplements are currently being taken by women before and during pregnancy and the post-childbirth period, and where women are receiving information on supplement use.

Data Management

All data collected will be anonymous and will be used only for this study. Participants will be identified only by a unique study identification code (not your name).

The questionnaire data will be stored on computers, which are protected by passwords, using only the unique study identification code and will be accessible only to the researchers. The project data will be stored as outlined above for 5 years.

Outcomes from this project may be published in scientific journals or presented at relevant conferences. These outcomes will be summary data only and not identify individual participant data.

Participant's Rights

You are under no obligation to accept this invitation. If you decide to participate, you have the right to:

- decline to answer any particular question;
- withdraw from the study at any time;
- ask any questions about the study at any time during participation;
- provide information on the understanding that all data collected will be done anonymously and any contact details given will only be used for the purpose of the study
- be given access to a summary of the project findings when it is concluded.

Project contacts

Ms Brianna Hunter (School of Sport, Exercise and Nutrition, Massey University),
Email: b.hunter@massey.ac.nz

Dr Cheryl Gammon (School of Health Sciences, Massey University),
Email: c.gammon@massey.ac.nz

Dr Ying Jin (School of Health Sciences, Massey University),
Email y.jin@massey.ac.nz

Committee Approval Statements

This project has been evaluated by peer review and judged to be low risk. Consequently, it has not been reviewed by one of the University's Human Ethics Committees. The researcher(s) named in this document are responsible for the ethical conduct of this research.

If you have any concerns about the conduct of this research that you want to raise with someone other than the researcher(s), please contact Professor Craig Johnson, Director (Research Ethics), email humanethics@massey.ac.nz.

Thank you for considering participating in this study!

Appendix D: The questionnaire

Block: Information Sheet (2 Questions)

Branch: New Branch

If

If Do you wish to continue? By agreeing to continue, you are consenting to be included in this part... No, I do not wish to be included in the research Is Selected

EndSurvey: Advanced

Standard: Eligibility Questions (4 Questions)

Branch: New Branch

If

If What month was your baby born? (in 2022) My baby was born in 2021 Is Selected

Block: Born in 2021 (1 Question)

EndSurvey:

Branch: New Branch

If

If Unfortunately you are not eligible to partake in this study as we are looking for participants li... Is Displayed

EndSurvey:

Branch: New Branch

If

If What month is your baby due? March Is Selected
Or What month is your baby due? April Is Selected
Or What month is your baby due? May Is Selected
Or What month is your baby due? June Is Selected
Or What month is your baby due? July Is Selected
Or What month is your baby due? August Is Selected
Or What month is your baby due? September Is Selected
Or What month is your baby due? October Is Selected

Block: Still Pregnant (1 Question)

Branch: New Branch

If

If Unfortunately at this time you are unable to complete the survey as we are looking for participan... I would like to receive an email reminder when I am eligible (enter email address below) Is Selected

Or Unfortunately at this time you are unable to complete the survey as we are looking for participan... No thank you Is Selected

EndSurvey:

Standard: Still Pregnant (1 Question)
Standard: Born in 2021 (1 Question)
Standard: Given birth (3 Questions)
Block: About you (7 Questions)
Block: Your pregnancy (9 Questions)
Block: Supplement use (10 Questions)
Block: Supplement use (10 Questions)
Block: Supplement use (10 Questions)
Block: Supplement use (14 Questions)
Block: Supplement use (7 Questions)

Page Break

Start of Block: Information Sheet

Q3 Dietary supplement use before, during and after pregnancy

My name is Brianna Hunter, and I am a postgraduate student undertaking a thesis project to complete a Master of Science degree in Nutrition and Dietetics at Massey University. I am under the supervision of Dr Cheryl Gammon and Dr Ying Jin from the School of Health Sciences at Massey University.

This study aims to explore what dietary supplements were taken by New Zealand women who have recently given birth, before they got pregnant, during the three trimesters of pregnancy and the period following the birth of their child. This study involves completing a short online survey.

Who are we looking for?

- women aged ≥ 18 years who reside in New Zealand,
- and have given birth in 2022,
- but have not used any assisted reproductive technologies (such as in-vitro fertilisation) to become pregnant due to increased specialist advice,
- and are able to complete the survey online in English

Please read the Full Information Sheet (a copy can be found [here](#)) before deciding whether you wish to take part in our study. You are under no obligation to participate in this study. Feel free to discuss with your family, whānau, and friends.

All data collected will be anonymous and will be used only for this study. Participants will be identified only by a unique study identification code (not your name).

The questionnaire will take 10-15 minutes to complete.

For further information please contact:

Ms Brianna Hunter (School of Sport, Exercise and Nutrition, Massey University), Email: b.hunter@massey.ac.nz

Page Break

Do you wish to continue? By agreeing to continue, you are consenting to be included in this part of the research.

- Yes, I consent to my responses to this survey being included in the research (1)
- No, I do not wish to be included in the research (2)

End of Block: Information Sheet

Start of Block: Eligibility Questions

Q1 Please select one of the following statements best describe you at this moment.

- I am living in New Zealand and aged over 18 years old and **currently pregnant** (1)
- I am living in New Zealand and aged over 18 years old and have **recently given birth** to my new baby (2)
- I am living outside of New Zealand or younger than 18 years old (3)

Display This Question:

If Please select one of the following statements best describe you at this moment. = I am living outside of New Zealand or younger than 18 years old

Q80 Unfortunately you are not eligible to partake in this study as we are looking for participants living in New Zealand and/or over the age of 18.

Display This Question:

If Please select one of the following statements best describe you at this moment. = I am living in New Zealand and aged over 18 years old and currently pregnant

Q2 What month is your baby due?

- March (7)
- April (8)
- May (9)
- June (10)
- July (11)
- August (12)
- September (13)
- October (14)

Display This Question:

If Please select one of the following statements best describe you at this moment. = I am living in New Zealand and aged over 18 years old and have recently given birth to my new baby

Q3 What month was your baby born? (in 2022)

- January (4)
- February (5)
- March (6)
- April (7)
- May (8)
- June (10)
- July (11)
- August (12)
- My baby was born in 2021 (9)

End of Block: Eligibility Questions

Start of Block: Born in 2021

Display This Question:

If What month was your baby born? (in 2022) = My baby was born in 2021

Q77 Unfortunately you are not eligible to partake in this research as we are looking for mums that have given birth within the last three months. If you know anyone that fits this criteria please send them the link to this study.

End of Block: Born in 2021

Start of Block: Still Pregnant

Display This Question:

If What month is your baby due? = March

Or What month is your baby due? = April

Or What month is your baby due? = May

Or What month is your baby due? = June

Or What month is your baby due? = July

Or What month is your baby due? = August

Or What month is your baby due? = September

Or What month is your baby due? = October

Q76 Unfortunately at this time you are unable to complete the survey as we are looking for participants who have given birth. If you would like to complete the survey once you have given birth, please provide your email address below and we will send you the link to the survey and a reminder at this time.

I would like to receive an email reminder when I am eligible (enter email address below) (4) _____

No thank you (7)

Skip To: End of Survey If Unfortunately at this time you are unable to complete the survey as we are looking for participan... = I would like to receive an email reminder when I am eligible (enter email address below)

Skip To: End of Survey If Unfortunately at this time you are unable to complete the survey as we are looking for participan... = No thank you

End of Block: Still Pregnant

Start of Block: Given birth

Display This Question:

- If What month was your baby born? (in 2022) = January*
- Or What month was your baby born? (in 2022) = February*
- Or What month was your baby born? (in 2022) = March*
- Or What month was your baby born? (in 2022) = April*
- Or What month was your baby born? (in 2022) = May*
- Or What month was your baby born? (in 2022) = July*
- Or What month was your baby born? (in 2022) = June*

Q4 Did you need help from a fertility clinic to get pregnant?

- Yes (1)
- No (2)
- Not sure - please contact Brianna at b.hunter@massey.ac.nz for any queries regarding this question (3)

Skip To: End of Block If Did you need help from a fertility clinic to get pregnant? = No

Page Break

Display This Question:

If Did you need help from a fertility clinic to get pregnant? = Yes

Q78 Unfortunately you are not eligible to partake in this research due to the increased specialist guidance you may have received.

Skip To: End of Survey If Unfortunately you are not eligible to partake in this research due to the increased specialist gu... Is Displayed

Page Break

Display This Question:

If Did you need help from a fertility clinic to get pregnant? = Not sure - please contact Brianna at b.hunter@massey.ac.nz for any queries regarding this question

Q79 Brianna will be in contact regarding your query, so you are able to best respond to this question. For the time being, if you know anyone who is currently pregnant or has recently given birth, please invite them to take this survey.

Skip To: End of Survey If Brianna will be in contact regarding your query, so you are able to best respond to this question... Is Displayed

End of Block: Given birth

Start of Block: About you

Q81 The following questions are about you.

Page Break

Q1 What is your age?

- 18-25 years (4)
- 26-30 years (5)
- 31-35 years (6)
- 36-40 years (7)
- >40 years (8)

Page Break

Q2 Which is the main ethnic group that you identify with most. Please select one.

- NZ European/Pakeha (1)
 - New Zealand Māori (2)
 - Cook Island Māori (6)
 - Fijian (3)
 - Samoan (7)
 - Tongan (8)
 - Other Pacific Island (9)
 - Other European (10)
 - Chinese (11)
 - South East Asian (12)
 - Other Asian (4)
 - Prefer not to answer (13)
 - Other (Please specify) (5)
-

Page Break

Q3 Were you born in New Zealand?

- Yes (1)
 - No (2)
 - Prefer not to answer (3)
-

Page Break

Q4 What is your highest qualification? Please select one.

- NCEA level 1/School certificate or NCEA level 2/6th form certificate or NCEA level 3 (1)
 - Polytechnic qualification or Trade Certificate (2)
 - Bachelors degree or higher (3)
 - None/No qualifications (4)
 - Other (please specify) (5)
-

Page Break

Q5 5. What is your current postcode? Please write the four-digit number in the box below.

If you do not know your postcode, please click [here](#) .

Please note: your postcode is for the area you live in, not your house. This is so we cannot identify who you are from your postcode.

Page Break

Q6 What was the total income from all sources for your household (before tax) over the last 12 months?

- Under \$40,000 (1)
- \$40,000 but less than \$70,000 (2)
- \$70,000 but less than \$100,000 (3)
- \$100,000 but less than \$120,000 (4)
- 120,000 but less than \$150,000 (5)
- \$150,000 or more (6)
- I don't know (7)
- Prefer not to answer (8)

End of Block: About you

Start of Block: Your pregnancy

Q82 The following questions are about your pregnancy.

Page Break

Q1 Is this your first pregnancy?

- Yes (1)
- No (2)

Skip To: Q3 If Is this your first pregnancy? = Yes

Skip To: Q2 If Is this your first pregnancy? = No

Page Break

Q2 How many other children do you have?

- 1 (1)
 - 2 or more (2)
 - Other (7)
-

Page Break

Q3 Was this pregnancy...

- Planned (1)
 - Unplanned (2)
 - Choose not to answer (3)
-

Page Break

Q4 Since your baby was born, have you breastfed your baby, this includes expressing milk?

- Yes (1)
 - No (2)
-

Page Break

Q7 Before your pregnancy was your health

- Poor (1)
- Fair (2)
- Good (3)
- Very good (4)
- Excellent (5)
- Do not know (6)

Page Break

Q8 Please select which best applies to how often you took dietary supplements (this includes vitamins and minerals) before you got pregnant.

- I regularly took dietary supplements (1)
- I occasionally took dietary supplements (2)
- I never took dietary supplements (3)

Page Break

Q9 Were you diagnosed with any medical conditions during your pregnancy? (please select all that apply)

- Iron deficiency (1)
 - Anaemia (2)
 - Hypertension (high blood pressure) (3)
 - Gestational Diabetes (4)
 - Hyperemesis Gravidarum/Morning Sickness (5)
 - Heartburn (6)
 - Other (please specify) (7)
-
- Non-applicable (8)

Page Break

Q10 During your pregnancy, who was your lead maternity carer (primary maternity care provider)?

- Midwife (1)
 - Doctor (GP: General Practitioner) (2)
 - Obstetrician (Specialist) (3)
 - Other (please specify) (4)
-
- Did not have one (5)
 - Choose not to answer (6)

End of Block: Your pregnancy

Start of Block: Supplement use

Q27 Folic Acid

The following questions are about your use of folic acid supplements before, during and after your pregnancy.

NOTE: These questions are about folic acid tablets on their own, not as part of a multivitamin preparation.

Page Break

Q1

Did you take 0.8mg or 5mg folic acid-**only** supplements?

- 0.8mg Folic Acid-only tablet (1)
 - 5mg Folic Acid- only tablet (please specify why) (2)
-
- Neither (3)

Skip To: Q2 If Did you take 0.8mg or 5mg folic acid-only supplements? = Neither

Skip To: Q3 If Did you take 0.8mg or 5mg folic acid-only supplements? = 0.8mg Folic Acid-only tablet

Skip To: Q3 If Did you take 0.8mg or 5mg folic acid-only supplements? = 5mg Folic Acid- only tablet (please specify why)

Page Break

Q2 Please indicate your reason(s) for not taking a folic acid-**only** tablet at any stage of your pregnancy.

- I was taking a multivitamin preparation that contained folic acid (1)
- I didn't receive any advice to take a folic acid supplement by my doctor/nurse/midwife (2)
- I could not tolerate them due to nausea or other side effects of pregnancy (3)
- Folic acid supplements were too expensive (4)
- I did not feel the need to as my health is good (5)
- I prefer to get all my nutrients from my diet (6)
- I cannot remember if I took them or not (7)
- Other (please specify) (8)

Skip To: Q6 If Please indicate your reason(s) for not taking a folic acid-only tablet at any stage of your pregn... = I was taking a multivitamin preparation that contained folic acid

Skip To: Q6 If Please indicate your reason(s) for not taking a folic acid-only tablet at any stage of your pregn... = I didn't receive any advice to take a folic acid supplement by my doctor/nurse/midwife

Skip To: Q6 If Please indicate your reason(s) for not taking a folic acid-only tablet at any stage of your pregn... = I could not tolerate them due to nausea or other side effects of pregnancy

Skip To: Q6 If Please indicate your reason(s) for not taking a folic acid-only tablet at any stage of your pregn... = Folic acid supplements were too expensive

Skip To: Q6 If Please indicate your reason(s) for not taking a folic acid-only tablet at any stage of your pregn... = I did not feel the need to as my health is good

Skip To: Q6 If Please indicate your reason(s) for not taking a folic acid-only tablet at any stage of your pregn... = I prefer to get all my nutrients from my diet

Skip To: Q6 If Please indicate your reason(s) for not taking a folic acid-only tablet at any stage of your pregn... = I cannot remember if I took them or not

Skip To: Q6 If Please indicate your reason(s) for not taking a folic acid-only tablet at any stage of your pregn... = Other (please specify)

Page Break

Q3 On average how often did you take folic acid-**only** tablets during the following periods

| | Most days of the week (6 to 7 days per week) (1) | Some days of the week (3 to 5 days per week) (2) | A few days of the week (1 to 2 days per week) (3) | Sporadically (less than once a week) (4) | Not taken (5) | Do not know/cannot remember (6) |
|---|---|---|--|---|-----------------------|--|
| In the 3 months before you were pregnant? (1) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| In the first 3 months (trimester) of pregnancy? (2) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| In the second 3 months (trimester) of pregnancy? (3) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| In the last 3 months (trimester) of pregnancy? (4) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| In the 6 weeks following birth? (5) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

Page Break

Q4 Why did you take a folic acid-**only** supplement?

- I was prescribed a folic acid-only supplement by my lead maternity carer (1)
 - I was advised to purchase a folic acid-only supplement by a health professional (GP, Midwife, Nurse, Obstetrician/Specialist, Pharmacist) (2)
 - I self-purchased and took a folic acid-only supplement (3)
 - Choose not to answer (4)
 - Other (please specify) (5)
-

Skip To: Q4a If Why did you take a folic acid-only supplement? = I was advised to purchase a folic acid-only supplement by a health professional (GP, Midwife, Nurse, Obstetrician/Specialist, Pharmacist)

Skip To: Q4a If Why did you take a folic acid-only supplement? = I self-purchased and took a folic acid-only supplement

Skip To: Q5 If Why did you take a folic acid-only supplement? = Choose not to answer

Skip To: Q5 If Why did you take a folic acid-only supplement? = Other (please specify)

Skip To: Q5 If Why did you take a folic acid-only supplement? = I was prescribed a folic acid-only supplement by my lead maternity carer

Page Break

Q4a Please specify which

- Doctor/GP (general practitioner) (1)
 - Midwife (2)
 - Nurse (3)
 - Obstetrician/Specialist (4)
 - Pharmacist (5)
 - Other (please specify) (6)
-

Skip To: Q5 If Please specify which = Doctor/GP (general practitioner)

Skip To: Q5 If Please specify which = Midwife

Skip To: Q5 If Please specify which = Nurse

Skip To: Q5 If Please specify which = Obstetrician/Specialist

Skip To: Q5 If Please specify which = Pharmacist

Skip To: Q5 If Please specify which = Other (please specify)

Page Break

Q4a I did this based on (please select all that apply).

- My own general knowledge (1)
 - It was recommended by family member (whanau/hākuikui) or friends (2)
 - Information found on the internet (3)
 - Information found in a book, newspaper, or magazine (4)
 - Do not know (5)
 - Choose not to answer (6)
 - Other (please specify) (7)
-

Page Break

Q4b Was your lead maternity carer aware that you were taking it?

- Yes (1)
 - No (2)
 - I cannot remember/do not know (3)
-

Page Break

Q5 Where did you obtain your folic acid-**only** supplement?

- Local pharmacy (1)
 - Online (2)
 - Other (please specify) (3)
-

I cannot remember/do not know (4)

Page Break

Q6 Do you know what health issues are associated with inadequate intake of folic acid? (please select all that apply).

- Neural tube defects (1)
- Goitre (2)
- Birth defects (3)
- Weak bones and teeth (4)
- Mental retardation (5)
- Impaired physical development during childhood (6)
- Blindness (7)
- Do not know (8)

End of Block: Supplement use

Start of Block: Supplement use

Q38 Iodine

The following questions are about your use of Iodine supplements before, during and after your pregnancy.

NOTE: These questions are about iodine tablets on their own, not as part of a multivitamin preparation.

Page Break

Q3 Did you take a 150µg iodine-**only** tablet?

- Yes (1)
- No (2)

Skip To: Q4 If Did you take a 150µg iodine-only tablet? = Yes

Skip To: Q4 If Did you take a 150µg iodine-only tablet? = No

Page Break

Q4 Please indicate your reason(s) for not taking an iodine-**only** tablet at any stage of your pregnancy.

- I was taking a multivitamin preparation that contained iodine (1)
- I didn't receive any advice to take a supplement by my doctor/nurse/midwife (7)
- I could not tolerate them due to nausea or other side effects of pregnancy (2)
- Iodine supplements were too expensive (3)
- I did not feel the need to as my health is good (4)
- I prefer to get all my nutrients from my diet (5)
- I cannot remember if I took them or not (8)
- Other (please specify) (6)
-

Skip To: Q89 If Please indicate your reason(s) for not taking an iodine-only tablet at any stage of your pregnancy. = I was taking a multivitamin preparation that contained iodine

Skip To: Q89 If Please indicate your reason(s) for not taking an iodine-only tablet at any stage of your pregnancy. = I could not tolerate them due to nausea or other side effects of pregnancy

Skip To: Q89 If Please indicate your reason(s) for not taking an iodine-only tablet at any stage of your pregnancy. = Iodine supplements were too expensive

Skip To: Q89 If Please indicate your reason(s) for not taking an iodine-only tablet at any stage of your pregnancy. = I did not feel the need to as my health is good

Skip To: Q89 If Please indicate your reason(s) for not taking an iodine-only tablet at any stage of your pregnancy. = I prefer to get all my nutrients from my diet

Skip To: Q89 If Please indicate your reason(s) for not taking an iodine-only tablet at any stage of your pregnancy. = Other (please specify)

Skip To: Q89 If Please indicate your reason(s) for not taking an iodine-only tablet at any stage of your pregnancy. = I didn't receive any advice to take a supplement by my doctor/nurse/midwife

Skip To: Q89 If Please indicate your reason(s) for not taking an iodine-only tablet at any stage of your pregnancy. = I cannot remember if I took them or not

Page Break

Q4 On average how often did you take iodine-**only** tablets during the following periods

| | Most days of the week (6 to 7 days per week) (1) | Some days of the week (3 to 5 days per week) (2) | A few days of the week (1 to 2 days per week) (3) | Sporadically (less than once a week) (4) | Not taken (5) | Do not know (6) |
|---|---|---|--|---|-----------------------|------------------------|
| In the 3 months before you were pregnant? (1) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| In the first 3 months (trimester) of pregnancy? (2) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| In the second 3 months (trimester) of pregnancy? (3) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| In the last 3 months (trimester) of pregnancy? (4) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| In the 6 weeks following birth? (5) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

Page Break

Q5 Why did you take an iodine-**only** supplement?

- I was prescribed an iodine supplement by my lead maternity carer (1)
 - I was advised to purchase an iodine supplement by a health professional (GP, Midwife, Nurse, Obstetrician/Specialist, Pharmacist) (2)
 - I self-purchased and took an iodine supplement (3)
 - Choose not to answer (4)
 - Other (please specify) (5)
-

Skip To: Q5a If Why did you take an iodine-only supplement? = I was advised to purchase an iodine supplement by a health professional (GP, Midwife, Nurse, Obstetrician/Specialist, Pharmacist)

Skip To: Q6 If Why did you take an iodine-only supplement? = I was prescribed an iodine supplement by my lead maternity carer

Skip To: Q5a If Why did you take an iodine-only supplement? = I self-purchased and took an iodine supplement

Skip To: Q6 If Why did you take an iodine-only supplement? = Choose not to answer

Skip To: Q6 If Why did you take an iodine-only supplement? = Other (please specify)

Page Break

Q5a Please specify which

- Doctor/GP (general practitioner) (1)
 - Midwife (2)
 - Nurse (3)
 - Obstetrician/Specialist (4)
 - Pharmacist (5)
 - Other (please specify) (6)
-

Skip To: Q6 If Please specify which = Doctor/GP (general practitioner)

Skip To: Q6 If Please specify which = Midwife

Skip To: Q6 If Please specify which = Nurse

Skip To: Q6 If Please specify which = Obstetrician/Specialist

Skip To: Q6 If Please specify which = Pharmacist

Skip To: Q6 If Please specify which = Other (please specify)

Page Break

Q5a I did this based on (please select all that apply).

- My own general knowledge (1)
 - It was recommended by family member (whanau/hākuikui) or friends (2)
 - Information found on the internet (3)
 - Information found in a book, newspaper, or magazine (4)
 - Do not know (5)
 - Choose not to answer (6)
 - Other (please specify) (7)
-

Page Break

Q5b Was your lead maternity carer aware that you were taking it?

- Yes (1)
 - No (2)
 - I cannot remember/do not know (3)
-

Page Break

Q6 Where did you obtain your iodine supplement?

- Local pharmacy (1)
 - Online (2)
 - Other (please specify) (3)
-

Page Break

Q89 Do you know what health issues are associated with inadequate intake of iodine? (please select all that apply).

- Neural tube defects (1)
- Goitre (2)
- Birth defects (3)
- Weak bones and teeth (4)
- Mental retardation (5)
- Impaired physical development during childhood (6)
- Blindness (7)
- Do not know (8)

End of Block: Supplement use

Start of Block: Supplement use

Q49 Iron

The following questions are about your use of iron supplements before, during and after your pregnancy.

NOTE: These questions are about iron tablets on their own, not as part of a multivitamin preparation.

Page Break

Q1 Did you take an iron-**only** supplement?

- Yes (1)
- No (2)

Skip To: End of Block If Did you take an iron-only supplement? = No

Page Break

Q2 Was the iron supplement you took...

- Prescribed by your midwife/doctor/specialist (1)
- Purchased (2)
- I cannot remember/do not know (3)

Skip To: Q93 If Was the iron supplement you took... = I cannot remember/do not know

Skip To: Q90 If Was the iron supplement you took... = Prescribed by your midwife/doctor/specialist

Skip To: Q91 If Was the iron supplement you took... = Purchased

Page Break

Q90 What type/brand of iron tablets did you have prescribed?

- Ferro-Gradumet (ferrous sulphate) (1)
 - Ferro-Tab (ferrous fumerate) (2)
 - Do not know (3)
 - Other (please specify) (4)
-

Skip To: Q93 If What type/brand of iron tablets did you have prescribed? = Ferro-Gradumet (ferrous sulphate)

Skip To: Q93 If What type/brand of iron tablets did you have prescribed? = Ferro-Tab (ferrous fumerate)

Skip To: Q93 If What type/brand of iron tablets did you have prescribed? = Do not know

Skip To: Q93 If What type/brand of iron tablets did you have prescribed? = Other (please specify)

Page Break

Q91 What type/brand of iron tablets did you purchase?

- Ferro-Gradumet (ferrous sulphate) (1)
 - Ferro-Tab (ferrous fumerate) (2)
 - Other e.g. Clinicians, Red Seal, Healtheries (please specify) (3)
-
- Do not know (4)
-

Page Break

Q92 I purchased the iron tablets based on (please select all that apply)

- Advice from my doctor/midwife/specialist (1)
 - My own general knowledge (2)
 - It was recommended by family member (whanau/hākuikui) or friends (3)
 - Information found on the internet (4)
 - Information found in a book, newspaper, or magazine (5)
 - Not sure (6)
 - Other (please specify) (7)
-
-

Page Break

Q5 Was your lead maternity carer aware that you were taking it?

- Yes (1)
 - No (2)
 - I cannot remember/do not know (3)
-

Page Break

Q6 Where did you obtain your iron supplement?

- Local pharmacy (1)
 - Online (2)
 - Other (please specify) (3)

 - I cannot remember/do not know (4)
-

Page Break

Q93 On average how many times a day did you take your iron tablets

- Once a day (1)
 - Twice a day (2)
 - Three times a day (3)
 - Other (please specify) (4)

 - I cannot remember/do not know (5)
-

Page Break

Q3 On average how often did you take iron-**only** tablets during the following periods

| | Most days of the week (6 to 7 days per week) (1) | Some days of the week (3 to 5 days per week) (2) | A few days of the week (1 to 2 days per week) (3) | Sporadically (less than once a week) (4) | Not taken (5) | Do not know (6) |
|---|---|---|--|---|-----------------------|------------------------|
| In the 3 months before you were pregnant? (1) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| In the first 3 months (trimester) of pregnancy? (2) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| In the second 3 months (trimester) of pregnancy? (3) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| In the last 3 months (trimester) of pregnancy? (4) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| In the 6 weeks following birth? (5) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

End of Block: Supplement use

Start of Block: Supplement use

Q58

Multivitamins

The following questions are about your use of multivitamin supplements before, during and after your pregnancy.

Page Break

Q94 Did you take a multivitamin at any stage before, during or after your pregnancy?

Yes (1)

No (2)

*Skip To: End of Block If Did you take a multivitamin at any stage before, during or after your pregnancy?
= No*

Page Break

Q1 Below are images of multivitamins available on the market in New Zealand. You may have taken more than one but select the one that you took the most throughout your pregnancy (Before you have given birth).

- Blackmores Conceive Well Gold Capsules + Tablets (1)
 - Elevit with Iodine (2)
 - Forever Mum –Preconception + Pregnancy Multi (3)
 - Healtheries Pregnancy and Breastfeeding Multi (4)
 - Radiance Preconception and Pregnancy Multi (5)
 - Solgar Prenatal Nutrients (6)
 - Swisse Ultinatal Preconception and Pregnancy multivitamin (7)
 - Blackmores Pregnancy and Breastfeeding Gold (8)
 - Vitawomenz Conception and Pregnancy Support (9)
 - Elevit Breastfeeding (10)
 - GO Healthy GO Pregnancy and Breastfeeding Advance (11)
 - Microgenics pregnancy support multivitamin (12)
 - BePure Mum’s One (13)
 - Fabfol tablets (14)
 - BePure Folate Restore (17)
 - Other (please specify) (15)
-

Page Break

Q95 Did you take a multivitamin after you had given birth?

- Yes (1)
- No (2)
- I cannot remember/do not know (4)

Skip To: Q98 If Did you take a multivitamin after you had given birth? = No

Skip To: Q98 If Did you take a multivitamin after you had given birth? = I cannot remember/do not know

Page Break

Q96 Was it the same multivitamin that you took during your pregnancy?

- Yes (1)
- No (2)

Skip To: Q98 If Was it the same multivitamin that you took during your pregnancy? = Yes

Page Break

Q97 From the images below select the one that you took the most in the 6 weeks after you had given birth.

- Blackmores Conceive Well Gold Capsules + Tablets (1)
 - Elevitwith Iodine (2)
 - Forever Mum –Preconception + Pregnancy Multi (3)
 - Healtheries Pregnancy and Breastfeeding Multi (4)
 - Radiance Preconception and Pregnancy Multi (5)
 - Solgar Prenatal Nutrients (6)
 - Swisse Ultinatal Preconception and Pregnancy multivitamin (7)
 - Blackmores Pregnancy and Breastfeeding Gold (8)
 - Vitawomenz Conception and Pregnancy Support (9)
 - Elevit Breastfeeding (10)
 - GO Healthy GO Pregnancy and Breastfeeding Advance (11)
 - Microgenics pregnancy support multivitamin (12)
 - BePure Mum’s One (13)
 - Fabfol tablets (14)
 - BePure Folate Restore (17)
 - Other (please specify) (15)
-

Page Break

Q98 On average how many times a day did you take a multivitamin tablet

- Once a day (1)
- Twice a day (2)
- Three times a day (3)
- Other (please specify) (4)
- I cannot remember/do not know (5)

Page Break

Q99 On average how often did you take a multivitamin tablet during the following periods

| | Most days of the week (6 to 7 days per week) (1) | Some days of the week (3 to 5 days per week) (2) | A few days of the week (1 to 2 days per week) (3) | Sporadically (less than once a week) (4) | Not taken (5) | Do not know (6) |
|---|---|---|--|---|-----------------------|------------------------|
| In the 3 months before you were pregnant? (1) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| In the first 3 months (trimester) of pregnancy? (2) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| In the second 3 months (trimester) of pregnancy? (3) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| In the last 3 months (trimester) of pregnancy? (4) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |
| In the 6 weeks following birth? (5) | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> | <input type="radio"/> |

Page Break

Q2 Why did you take a multivitamin supplement?

- I was advised to purchase a multivitamin supplement by a health professional (GP, Midwife, Nurse, Obstetrician/Specialist, Pharmacist) (2)
 - I self-purchased and took a multivitamin supplement (3)
 - Choose not to answer (4)
 - Other (please specify) (5)
-

Skip To: Q2a If Why did you take a multivitamin supplement? = I was advised to purchase a multivitamin supplement by a health professional (GP, Midwife, Nurse, Obstetrician/Specialist, Pharmacist)

Skip To: Q2a If Why did you take a multivitamin supplement? = I self-purchased and took a multivitamin supplement

Skip To: Q3 If Why did you take a multivitamin supplement? = Choose not to answer

Skip To: Q3 If Why did you take a multivitamin supplement? = Other (please specify)

Page Break

Q2a Please specify which

- GP (general practitioner) (1)
 - Midwife (2)
 - Nurse (3)
 - Obstetrician/Specialist (4)
 - Pharmacist (5)
 - Other (please specify) (6)
-

Skip To: Q3 If Please specify which = GP (general practitioner)

Skip To: Q3 If Please specify which = Midwife

Skip To: Q3 If Please specify which = Nurse

Skip To: Q3 If Please specify which = Obstetrician/Specialist

Skip To: Q3 If Please specify which = Pharmacist

Skip To: Q3 If Please specify which = Other (please specify)

Page Break

Q2a I did this based on (please select all that apply)

- My own general knowledge (1)
 - It was recommended by family member (whanau/hākuikui) or friends (2)
 - Information found on the internet (3)
 - Information found in a book, newspaper, or magazine (4)
 - Do not know (5)
 - Choose not to answer (6)
 - Other (please specify) (7)
-

Page Break

Q2b Was your lead maternity carer aware that you were taking it?

- Yes (1)
 - No (2)
 - I cannot remember/do not know (3)
-

Page Break

Q3 Where did you obtain your multivitamin supplement(s)?

Local pharmacy (1)

Online (2)

Other (please specify) (3)

I cannot remember/do not know (4)

Page Break

Q100 If you took more than one brand of multivitamin supplement **before or during** your pregnancy, can you please tell us here a bit more about that - what other brands you took, how many a day and how often you took them and during what periods of your pregnancy.

End of Block: Supplement use

Start of Block: Supplement use

Q77 Other supplements and final questions

The following questions are about your use of other supplements (including other vitamin and mineral products, herbal products, traditional medicine products) before, during and after your pregnancy.

Page Break

Q1 Before, during or after your pregnancy, did you take any other supplements? These may include any other vitamin and mineral products, herbal products and traditional medicine products.

Yes (1)

No (2)

Skip To: Q4 If Before, during or after your pregnancy, did you take any other supplements? These may include any... = No

Page Break

Q2 Can you tell us a bit more about what supplements you took and why you took them? (e.g. Omega-3 capsules – A friend told you need extra of these during your pregnancy; Probiotics – I had read these could reduce the risk of the baby having allergies)

Before pregnancy (1)

During Pregnancy (2)

After pregnancy (3)

Page Break

Q3b If you did take other supplements during your pregnancy, was your lead maternity carer aware that you were taking them?

Yes (1)

No (2)

I cannot remember/do not know (3)

Page Break

Q4 During your pregnancy, was your access to healthcare affected due to COVID-19?

Yes (please specify) (1)

No (2)

Page Break _____

Q101 During your pregnancy, do you think your supplement use was affected by COVID-19?

Yes (please specify) (1)

No (2)

Page Break _____

Q102 Is there anything else that you would like to tell us about any of your supplement use before, during or in the 6 weeks following birth.

End of Block: Supplement use

Appendix E: Example of social media posts

Papakura & Takaanini Grapevine



Brianna Hunter · 20 Apr 2022 ·

Remove if not allowed

Hello! I'm Brianna Hunter and I am a dietetics student at Massey University in Auckland. I am completing my thesis research project on supplementation before, during and after pregnancy. Our online questionnaire has just gone live, and we are looking for participants! If you are over 18, have given birth in 2022 or know someone that has we would love if you could spend 10-15 minutes completing our questionnaire.

If you have any questions please feel free to email me at b.hunter@massey.ac.nz otherwise follow the link below to take you to the survey or share to anyone you might know!

https://massey.au1.qualtrics.com/jfe/form/SV_7aJFfTIfJ7J4ntQ

Papakura & Takaanini Grapevine



Brianna Hunter · 19 Jul 2022 ·

Brianna Hunter

19 Jul 2022 ·

Hi! My name is Brianna Hunter, I am a dietetics student at Massey University, and I urgently need some more people to complete my short online questionnaire on supplement use around pregnancy for my dietetic research project.

If you have had a baby since the beginning of the year, can you please complete the survey or share it with any of your whānau or friends who have had a baby.

https://massey.au1.qualtrics.com/jfe/form/SV_7aJFfTIfJ7J4ntQ

Appendix F: List of Facebook groups joined

- Beachhaven and Birkdale
- Birkenhead and Northcote community
- Blenheim, Marlborough, New Zealand
- Breast feeding and pumping gear for sale NZ
- Breast feeding mums, West Coast, NZ
- Browns Bay buy and sell
- Browns bay buy and sell
- Browns bay north shore NZ
- Buy and sell baby and kids clothes NZ
- Buy sell and trade Chch
- Buy sell and trading Ashburton
- Buy sell swaps Whangarei
- Buy sell trade Chch
- Buy, sell, swap maternity and breastfeeding clothing only NZ
- Chch news social and community
- Christchurch buy sell trade
- Christchurch buy/sell/trade whatever you want
- Christchurch community notices/buy/sell/trade
- Devonport Locals Facebook Group (NZ)
- Dietitians NZ forum
- Dunedin area buy sell trade
- Dunedin buy sell trade
- Dunedin buy/sell/trade
- East Auckland grapevine
- Ferrymead/mt pleasant/Sumner/Redcliffs community page
- Forrest hill north shore community
- Glen Eden, Henderson, Sunnyvale & Oratia Area Community
- Hauraki, Takapuna, Milford, Forrest Hill
- Hawkes Bay buy/sell/swap
- Heathcote valley community
- Henderson community (west Auckland)
- Kaiapoi community group
- Kaiapoi community group
- Kmart mums NZ
- La Leche League NZ fb page
- Methven noticeboard NZ
- Milford locals
- Mothers milk NZ charitable trust fb (messed) (emailed)
- Mount Eden community notice board
- Mummy support group NZ
- Mums in Auckland
- Mums in Hawkes Bay
- Mums NZ buy and sell no rules
- Mums of Dunedin
- Napier only swaps/sell/buy

- New Zealand mums
- New Zealand womans discussion group
- NZ mums due 2022
- Oamaru Community Noticeboard
- Palmerston North Community
- Papakura and Takanini grapevine
- Queenstown buy/sell/trade
- South Auckland Papatoetoe buy sell and swap
- St Albans Christchurch community group
- St Albans Christchurch community group
- Sunnynook/Totravale/Forrest Hill community group
- Takapuna, Milford and nearby
- The mum hub
- The mums collective
- The official Lower Hutt community notice board
- Timaru Buy Sell Swap
- Wanaka clothing buy/sell/trade
- West Auckland and surrounding areas community notice board
- West Auckland community New Zealand
- Westcost NZ community board
- Whangarei community page
- Whangarei Heads Community Page
- Whats news Dunedin