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EFFECTIVENESS OF NUTRITION EDUCATION ON NUTRIENT INTAKE AND PREGNANCY OUTCOMES IN MIGORI COUNTY, WESTERN KENYA

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ABSTRACT

Maternal nutrition is critical as it lays fundamental foundation for the successful outcome of pregnancy. Kenya's high rates of under nutrition among women of reproductive age are due to sub-optimal feeding practices, inadequate nutrient intake and insufficient knowledge on nutritionally adequate diets leading to poor pregnancy outcomes. This study assessed nutrient intakes and pregnancy outcomes among pregnant women of about 22 weeks gestation exposed to a psycho-educational nutrition initiative in Migori County. A prospective cohort study design and simple random sampling was used to obtain a sample of 150 pregnant women who were enrolled into the Intervention Study. Data was collected using 24-hour dietary recall, anthropometric measurements and health records and was analysed by Nutri-Survey and SPSS and tested using t-tests and regression model. The mean of macronutrient intakes at baseline were 1613±439 kcal for energy, protein 62.6±24.6 g, carbohydrates 245±7 g, fat 41±2 g and after the intervention, mean energy intake was 2159±309 Kcal, protein 86±2 g, carbohydrates 312±6 g and fat 61±3 g. There was a significant improvement in the intakes for all the macronutrients after four months exposure to the intervention. The mean micronutrient intakes by the women at baseline were, vitamin A, 1255±2131 µg, folic acid, 197±7 µg, vitamin C 67±4 mg, calcium 300±141 mg, iron 115±3 mg and zinc 12±4 mg. The mean intakes after the intervention were, Vitamin A 1750±3560 µg, folic acid 249±7µg, vitamin C 90±6 mg, calcium 442±2 mg, iron 15±3 mg and zinc 16±4 mg. There was a significant increase in intake of all micronutrients after the intervention. Mean gestation age at recruitment was 21 weeks, gestation age at delivery was 37.7 weeks. The mean birth weight was 3098±5 grams. Babies born before 37 weeks gestation were 32.6 % while 67.4 % were born at ≥37 weeks gestation. Coefficients of determination (R^2) from the regression model showed that there were positive significant effects of nutrition knowledge obtained from the psycho-educational initiative on nutrient intake after the intervention and on pregnancy outcomes. The intervention had a significant effect on nutrient intake and pregnancy outcomes and should be strengthened in the healthcare system to improve nutrition knowledge and dietary practices for enhanced nutrient intakes and pregnancy outcomes.

Key words: Pregnant women, Nutrition Education, Nutrient intake, Pregnancy outcomes

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INTRODUCTION

Women make up a little over half of the world's population but they account for over 60% of the world's hungry [1]. Maternal nutrition is critical for both mother and child as it lays fundamental foundation for the successful outcome of pregnancy [2]. Nutrient related deficiency diseases and micronutrient deficiencies which can result in intrauterine growth retardation are manifested worldwide [3]. Hidden hunger affects more than one in three of the world's population in developed and developing countries [4]. Malnutrition in women including pregnant women is not conspicuous and remains to a large extent unaccounted for and unreported, thus insufficient attention has been given to its extent, causes and consequences [4]. As a result, inadequate resources and efforts have been allocated to improving women's nutrition compared with other nutritional and public health actions. Women's child bearing roles, their pre and post natal health and nutritional status are important determinants of the survival and development of their foetus and new-born child.

In developing countries, low birth weight babies account for 14 % of all births [5]. According to World Health Organization (WHO), 15 million babies worldwide are born preterm, one million die yearly due to complications of being born before term. Many survivors face a lifetime of disabilities including learning disabilities, visual and hearing problems [5]. More than 7 million new-born deaths worldwide are associated with maternal health and nutrition related problems resulting from poorly managed pregnancies among others [6]. Kenya is among 15 countries with a high number of preterm births; over 180,000 babies are born premature and 15,000 die each year. Poor maternal nutrition among mothers increase the likelihood of a premature birth [5]. Half of Kenyan mothers are deficient in at least one micronutrient and many mothers have multiple micronutrient deficiencies. Several interventions are provided at the Ante-natal clinic (ANC) as recommended by WHO [7]. Nutrition Education and counselling has not been brought out clearly in this healthcare package for pregnant women [8], and its impact cannot be quantified.

Creating nutrition awareness among pregnant mothers is important. Nutrition education and counselling during pregnancy can reduce the risk of anaemia, increase gestational weight gain and improve birth weight [9]. Positive behaviour adjustments by participants in Nutrition Education and Counselling interventions have been reported by several authors [7, 9]. Nutrition education intervention is, therefore, an essential consideration to optimise maternal nutrition and pregnancy outcomes. Scaling up maternal and child nutrition is important. The economic implication of this may be high in certain countries, but every dollar spent on this package generates around $18 in economic benefits. By the standards of economics, these are impressively high benefit: cost ratios [10]. According to Quinn [11], the window of opportunity is small (first 1000 days), a period beginning from conception to two years of age when children develop faster than at any other time in their lives Interventions must focus on this window of opportunity; any investments after this critical period of 1000 days are much less likely to improve nutrition.

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It is important to give women support for optimal nutrition before and after they become pregnant, in order to promote good nutrition. According to Schultink, to improve local and global health and development, there is need to scale up nutrition [12]. Moreover, given the close links between maternal and child nutrition, efforts to improve the nutritional status of women are critical to attaining global nutrition targets of the Sustainable Development Goal 2; to end hunger, and achieve food security and improved nutrition [13]. The study sought to assess intake of selected nutrients before and after exposure to psycho-educational nutrition initiative, determine pregnancy outcomes and determine their associations in Migori County.

METHODOLOGY

The study adopted a prospective cohort study design. The study followed groups of pregnant women exposed to nutrition psycho-education for four to six months. After baseline information was collected, cohorts were followed longitudinally, to determine whether their exposure status changed outcomes. The study area was Migori County. The County is located in Western Kenya and borders Lake Victoria to the south west. It is made up of an area of 2,597 km^2 with an estimated population of women of reproductive age of 263,602 [14]. The study population comprised pregnant women visiting selected healthcare facilities for antenatal care. Pregnant women between 10 and 26 weeks gestation were targeted and included those with a documented medical history or who reported a history of disordered eating, but the diagnosis not listed in the exclusion criteria, those who resided in the county for at least 6 months and those who gave consent to participate in the study.

Women were randomly sampled daily as they arrived at purposively selected health facilities for 30 working days until the required sample size was obtained. The sample size was determined by Fisher's formula of 1991, for sample size determination [15]. A proportion of 10 % was added to the sample size to compensate for non–response and possible attrition, giving a final sample size of 150.

Data Collection Procedure and Tools

Research Assistants who included qualified registered nurses in the hospitals were trained on data collection techniques, content of the nutrition resources and on pedagogical skills. Researchers and assistants then proceeded to the various health facilities for sample selection and recruitment. Informed consent was sought from the women before enrolment into the psycho-educational nutrition study. Upon recruitment, baseline data were collected and women followed up until delivery. Twenty four-hour dietary recall questionnaire was used to obtain dietary intake information while medical records were used to obtain data on gestation age. Nutrition knowledge that was rated on a scale of 1-5 was measured before and after intervention. Birth weight was obtained using a portable baby scale. A pilot run was done three months prior to the actual research. The intervention was nutrition education entailing monthly individual and group counselling and daily interaction with educative resources on adequate diet, reduction of physical activity, weight gain, hygiene and best practices during pregnancy, intended to bring positive behaviour change and optimal feeding habits to improve pregnancy outcomes. Data collection was hospital-based. Data for each participant were coded and these were used for data entry and analysis.

The 24-hour dietary recall was administered through a face-to-face interview schedule. The subjects were required to recall all the foods consumed, the time the food was eaten, a description of the food item, method of preparation, ingredients used in food preparation and how much of the food they had consumed the previous day from the time they woke up in the morning to the time of going to bed, and these were recorded for each participant for each day. The 24-hour recall interview was repeated for a separate day of the same week. Bowls, cups, spoons and specifically designed food models and other standard cooking measures were presented to participants during the interviews to assist them in providing information on the quantities of each food consumed. Thorough and in-depth probing of participants and the use of these equipment enabled research assistants to verify the quantities of food that were consumed. After all foods and beverages were recorded, follow- up questions on snacks and any other foods were asked to make sure nothing was forgotten. A nutrition knowledge questionnaire with a rated score of 1-5 was also administered to determine nutrition knowledge. These were administered during the first contact and at the end of the intervention in the hospitals' ANC sections.

Ninety-two respondents who delivered in hospitals were able to be followed up to obtain birth weights**.** Others could not be traced during delivery as they may have delivered at home. New borns were weighed with no clothing within 24 hours after birth using a portable baby scale with a capacity of 5 kg and a precision of 10 g. The weighing scale was calibrated before each weighing and results were recorded to the nearest gram on an anthropometric form. Data were cleaned and entered into excel spreadsheet. Weights of foods from 24-hour recall were converted from household measures into grams and then into intake values for energy, protein, fat, iron, zinc, and vitamin A by Nutri-survey Computer Package. Local measuring utensils were identified and their weights and volumes determined. Data were transferred to SPSS and analysed using frequencies and descriptive statistics while t-tests and regression model were used to test for relationships among variables with statistical significance taken at $P < 0.05$.

A research permit (No. NACOSTI/P/16/05583/12080) was obtained from National Commission for Science, Technology and Innovation (NACOSTI), Kenya. Ethical clearance was granted by Kenyatta University Ethical Review Committee. Permission to carry out research was obtained from all the relevant administrative offices. Project administration was sought from the Medical Officers in- Charge at all the selected health facilities. Participation in the study was purely voluntary and informed consent was obtained from the pregnant women who participated in the study.

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RESULTS AND DISCUSSION

Nutrient Intakes of the Pregnant Women

The mean macronutrient intake at baseline were (n = 136): energy; 1613±439Kcal, protein 62.6±23.6g, carbohydrates 244.9±7.2g, fat 40.5 ±23g and after the intervention, mean energy intake was 2158.7±309.8Kcal, protein 85.5±23.8g, carbohydrates 311.7±58.4g and fat 60.8±24.6g. There was a significant improvement in the intakes for all the macronutrients after the intervention. The mean micronutrient intake at baseline was vitamin A; 1254.8±2131.5µg, folic acid; 197±67.2µg, vitamin C; 66.7±42.1mg, calcium; 299.7±142.5mg, iron; 10.6±2.8mg and zinc; 11.5±3.8mg. The mean intake after the intervention (n =115) were vitamin A; 1749.6±3560.4µg, folic acid; 249.4±67.2µg, vitamin C; 89.9±61.1mg, calcium; 442±177.9mg, iron; 14.9±3.2mg and zinc; 15.6±3.7mg (Table 1). There was a significant increase in intake of all micronutrients after the intervention (Table2).

Only zinc, vitamin A, carbohydrate and fibre intakes (104.6%, 163% 140% and 111.4% respectively) were above Recommended Dietary Allowance (RDA) at baseline. After the intervention, the percentage of RDA increased for all nutrients except energy (89.9%), folic acid (41.6%), calcium (44.2%) and iron (55.1%) intake which increased but were still below RDA. Intake of zinc, vitamin A and carbohydrate were above RDA at both baseline and after the intervention. Percentages of RDA for folic acid, iron and calcium at baseline were less than the average percentage of RDA, and only percentage of RDA for iron intake rose to slightly above average after intervention. A few of the women managed to meet the RDA requirement for folic acid and iron at baseline but surprisingly, after the intervention all the women had intakes below the RDA (46.1% and 55.1%) (Table 1). This finding on iron and folic acid intakes confirms the report that diets of women in poor settings are usually deficient in iron and folic acid [3]. Becquaey *et al.* [16] states that the diet of populations in developing countries cannot meet all of the iron requirements of pregnant women especially those who begin pregnancy on low reserves. However, concern about iron and folic acid is mitigated by the iron and folic acid supplements given at the ANC during each visit.

Intake of nutrients below RDA can be a risk factor for nutritional deficiencies. According to Becquaey *et al.* [16] deficiencies in iron, vitamin A, calcium and folic acid among others can lead to increased risk of low birth weight and preterm births as well as foetal deaths. The findings from this study on nutrient intakes at baseline are consistent with those obtained by Odiwuor *et al.* [17] in the same area of study that found intake of all nutrients except vitamin C and fiber to be below RDA. However, intakes after the intervention were above RDA for most nutrients indicating that nutrient intake in this study sample may have been improved by the intervention. These findings support the Kenya Situation Analysis Report that micronutrient deficiencies are common among pregnant women and specify that vitamin A, zinc, iron and iodine deficiencies are the most prevalent [18]. Previous studies have shown that the effect of consuming different foods on birth outcomes varies according to the stage of pregnancy. The effect of nutrient deficiencies on foetal growth will differ depending on the time they occur [19], for example third trimester is the time of most rapid weight gain of the foetus, other foetal outcomes like foetal length gain peaks before this period.

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Increases in energy, protein, fat, carbohydrate, fibre, vitamin C, calcium, and iron and zinc intake at baseline and at the end of the intervention were positive and statistically significant at $p \leq 0.05$. Only vitamin A intake had no significant difference at baseline and after intervention. Further investigation may be needed to unveil the possible cause of lack of significant increase in intake of vitamin A among the women. These study findings underscore the important benefits which nutrition policies directed towards food based approaches can produce even in situations where resources are scarce. Although food security may not be ensured, it can still be practical to promote an optimal diet based on local foods to ensure adequate foetal growth.

Outcomes

The mean gestation age at recruitment was 21.2±4.2 weeks and 37.7±2.3 weeks at delivery (Table 3). The new-borns attained normal (≥2500gm) and above birth weight, attaining a mean birth weight of 3097.8±489.7grams. Babies born before 37 weeks gestation were 32.6% while 67.4 % were born at ≥37 weeks gestation. The mean birth weight of new-borns was normal with most having a normal and above normal birth weight, only a few (7%) had below normal birth weight (Table 4).

The survival of babies who are born before 37 weeks gestation is dependent on a myriad of factors [5]. In Kenya, a considerable number of babies (193,000) are born alive before 37 weeks of gestation annually, of the preterm babies born, 8 % weigh less than 2.5 kg and a preterm baby has just a small chance (12 %) of being born alive [20]. Data from the Ministry of Health, Kenya indicate that about 13,300 children under five years die annually due to preterm complications [7]. This report supports our finding of 32.6% preterm births but then continues to elucidate on the implications of preterm births on the health of the new born. A Kenyan study conducted in South Nyanza where the study area falls found that preterm delivery was a risk factor for LBW and found an unusually high incidence of preterm deliveries with about half of all live births preterm [21]. Other studies in sub-Saharan Africa have also reported rather high preterm births up to about 20 % [7].

A recent Kenyan study found majority of the pregnant women (82 %) to have had mature deliveries and only 7 % had preterm births [20]. The mean birth weight was 2928±5 g. The finding of term births is comparable to those from this study where most of the women (67.4 %) had term deliveries but differs where a considerably higher proportion of the women had preterm deliveries (32.6 %) and others had higher birth weight (3098±489 g) as identified. A study on improved pregnancy outcomes in Western Kenya [22] the same region of this study, found a birth weight of 3202 g which is almost similar to the finding in this study. Another study in Tanzania found a prevalence of LBW of 13.6 % [23] and in Ethiopia, one hospital study found a LBW prevalence of 17.1 % [24]. These are much higher than the finding in this study and may be an indication that the situation in other areas of sub-Saharan Africa may be worse than among this study population. There seems to be a common and similar pattern of LBW in Developing Countries. Several reports support this common trend [4, 25].

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Several studies show that dietary counselling interventions aimed at increasing dietary intakes are most successful in increasing birth weight [9, 10]. Young *et al.* [25] recommends that nutrition education and counselling programs and support to women should be introduced early in pregnancy to optimize infant birth outcomes. In this study, there was an effort to reach the women early with the PNI where almost 60 percent of the women were ≤20 weeks gestation. This may probably be one reason why birth weight of most new-borns was adequate. However, Young *et al.* [25] continues to state that many women do not seek antenatal care until mid-pregnancy (≈20 weeks). In many resource-poor settings alternative strategies for reaching women before and in early pregnancy need to be considered**.** In view of this report and the observation from this study where a high proportion of women were reached after gestation age of 20 weeks, nutrition education should be administered starting at the household level before they seek antenatal care in order to improve pregnancy outcomes among this cohort.

Effect of Nutrition Education on Nutrient Intake, and Pregnancy Outcomes

The regression (R^2) model registered a value of 0.722 on nutrition intake on pregnancy outcomes, 0.635 on nutrition knowledge on nutrient intake, 0.537 of nutrition knowledge on pregnancy outcomes and 0.698 of a combination of nutrient intake and pregnancy outcomes after intervention (Table 5). These variations indicate significant associations with nutrition knowledge, and therefore, there is a significant effect of the nutrition education initiative on nutrient intake and pregnancy outcomes ($p \leq 0.05$) of women in Migori County, contributed significantly by nutrient intake followed by pregnancy outcomes (Table 6).

A study on delivery of prenatal health education and pregnancy outcomes in Baatan concluded that prenatal education had a significant relationship with pregnancy outcomes and, therefore, prenatal education must be an essential component in upholding the overall health status for pregnant women [26]. This is an indication that a healthy pregnancy starts with proper nutrition to bring out positive pregnancy outcomes. A study to determine level of nutrition awareness showed that it would be desirable to set up an awareness raising program with the aim of increasing the level of education of pregnant women in terms of eating behaviour and nutrition status [27]. Another study concluded that nutrition education could improve knowledge and practices of women during pregnancy and that attention should be given to promote nutrition education during ANC visits for pregnant women [28]. All the studies reviewed here indicate that nutrition education has positive and significant effects on nutrient intake and pregnancy outcomes and supports this study that found significant effects of nutrition education on nutrient intake and pregnancy outcomes. It is essential, therefore, that the health system recognize nutrition education as a need and priority area for women who are pregnant. Healthcare providers need to increase public awareness of the importance of prenatal dietary and health behaviours by using information and tools across several appropriate channels.

Simple cost effective and sustainable interventions and their increased access are needed to reduce the burden on the health care system [29, 30] as well as mitigate other factors created by LBW. Nutrition education is one such cost effective intervention that can be implemented and sustainably used to bring about behaviour change for improved nutrition and pregnancy outcomes. In Kenya, the main objective for many health interventions targeting pregnant women is to reduce maternal and infant mortality and not maternal under-nutrition [5]. There is, therefore, opportunity to design health initiatives addressing both mortality and under-nutrition. As observed in this study, there are gaps in maternal dietary counselling/nutrition education for pregnant women in the health care system. Nutrition education programs need to be integrated into the primary health care for pregnant women and their uptake scaled up.

CONCLUSION

Most nutrient intakes increased after intervention although some nutrient intakes were still inadequate. Intake of energy, folic acid, calcium and iron were inadequate before and after intervention. However, many women were taking iron-folic supplements from ANC and our findings underscores the need for this supplementation as meeting requirements by food alone is difficult. Other nutrients had intakes above RDA after intervention. The mean gestation age at delivery was normal. The mean birth weight was adequate. Most babies were born at term. Proportion of preterm birth was higher than those from most studies. Proportions of LBW compares well with those of other studies in Kenya and other developing countries. The mean birth weight supports the Developing Countries' trend indicating lower prevalence of LBW. The psycho-educational nutrition initiative had significant effects on nutrient intake and pregnancy outcomes of pregnant women.

The study suggests that the Ministry of Health needs to incorporate nutrition education into existing programming within the primary health care system and also target pregnant women at the household level to increase effectiveness of the programme. The study observed that dietary intake of folic acid, iron and calcium could not meet the RDA even after the nutrition education intervention. Other factors may have been at play to reduce the intakes. This hypothesis however may need to be tested before conclusive remarks can be made. Other reports [5, 10, 29] also indicate that diets in resource-poor settings hardly provide adequate amounts of these micronutrients. The Ministry of Health together with other Health Agencies need to enhance and evaluate interventions aimed directly at meeting adequate intakes, such as iron and folic acid supplementation and the pregnant women to be tracked to ensure total compliance. Other long- term strategies such as post-harvest fortification for calcium, folic acid and other essential micronutrients need to be considered by the government.

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Table 1: Nutrient Intakes of Pregnant Women

	Baseline (n = 136)			Post-Intervention (n= 115)		
Nutrient	**Mean**	**SD**	**% RDA**	**Mean**	**Std. Dev**	**% RDA**
Energy (kcal)	1613	439	67	2159	309	89
Water (g)	942	358.2	94.1	1170.9	319	117.0
Protein (g)	62.6	23.4	88.2	85.5	23.8	120.5
Carbohydrates (g)	244.9	65.2	140	311.7	58.4	178.0
Dietary fibre (g)	31.2	10.1	111.4	39.9	8.0	142.4
Vitamin A (µg)	1255	2032	163	1750	3560	227
Folic Acid (µg)	197	67.2	32.8	249.4	67.2	41.6
Vitamin C (mg)	66.7	42.1	78.5	89.9	61.1	105.8
Calcium (mg)	299.7	142.5	30	442	177.9	44.2
Iron (mg)	10.6	2.9	39.1	14.9	3.2	55.1
Zinc (mg)	11.5	3.8	104.6	14.6	3.7	132.9

RDA obtained from: Food and Nutrition Board, Institute of Medicine, National Academies, 2011. Dietary Reference Intakes (DRIs), Recommended Dietary allowances and Adequate Intakes, DRI table and Application Reports. USDA, United States Department of Agriculture, National Agricultural Library, Food and Nutrition Centre. www.nal.usda.gov./fnic/dri-tables

Table 2: Test for differences between means of nutrient intakes at baseline and after intervention

Nutrient	Mean Post intervention (n=115)	Mean Baseline (n=136)	P value
Energy (kcal)	2159	1613	.987
Protein (g)	85.5	62.6	.764
Fat (g)	85.5	62.6	.639
Carbohydrates (g)	311.7	244.9	.792
Dietary fiber (g)	39.9	31.2	.337
Vitamin A (µg)	1750	1255	.689
Folic acid (µg)	249.4	197	.750
Vitamin C (mg)	89.9	66.7	.525
Calcium (mg)	442	299.7	.275
Iron (mg)	14.9	10.6	.526
Zinc (mg)	14.6	11.5	.971

$P \leq 0.05$, df = 136 (Baseline), 115 (Post intervention), $P \leq 0.05$
RDA obtained from: Food and Nutrition Board, Institute of Medicine, National Academies, 2011, t value from paired t-test

Table 3: Pregnancy outcomes of pregnant women

Pregnancy Outcome	n	Mean	Std. Dev.
Gestation age (weeks) at recruitment	136	21.2	4.3
Gestation age (weeks) at delivery	92	37.7	2.3
Birth weight of new-born (g)	92	3097.8	489.7

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Table 4: Gestation age and New Born Birth Weight Categories

	Pregnancy Outcome	Frequency	Percentage
Gestation age at recruitment (n = 136)	First trimester (0-3 months)	8	5.9
	Second trimester (4-6 months)	128	94.1
Gestation age at delivery (n= 92)	Preterm Births (<37 weeks)	30	32.6
	Term Births (≥37 weeks)	62	67.4
Birth weight of New borns (n = 92)	Low birth weight (< 2.5 kg)	6	7.0
	Normal and above birth weight (≥ 2.5 kg)	86	93.0

Table 5: Regression Model of Nutrition Knowledge with Nutrient Intake and Pregnancy Outcomes

Independent Variable	Independent Variables	R	R^2
Nutrition Intake p*	Pregnancy Outcomes	0.849	0.722
Nutrient Intake b*	Pregnancy Outcomes	0.038	0.001
Nutrition Knowledge	Nutrient Intake b*	0.102	0.010
Nutrition Knowledge	Nutrient Intake p*	0.457	0.635
Nutrition Knowledge	Pregnancy Outcomes	0.467	0.537
Nutrition Knowledge	Nutrient Intake p*, Pregnancy Outcomes	0.312	0.698
Nutrition Knowledge	Nutrient Intake b, Pregnancy Outcomes	0.039	0.115

p*- Post Intervention, b*- baseline

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