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Hydration Status, Fluid Intake and Determinants among Pregnant Women (23-35 Years) Attending Public Hospitals in Nsukka Local Government Area

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Abstract

This study investigated hydration status, fluid intake, and the determinants among pregnant women aged 23-35 years attending three healthcare centers in Nsukka Local Government Area (LGA). Specifically, it assessed hydration states of respondents using urine specific gravity and serum osmolality; fluid intake and determinants of fluid intake of the respondents. A total of 310 pregnant women participated in the study. Cross-sectional survey design was adopted. Refractometer and serum osmolality elicited information on the hydration status, a 3-day fluid record questionnaire assessed the fluid intake while a 5-point scale questionnaire identified the determinants of fluid intake. Data were analyzed using frequency, percentages, means, standard deviation and Chi square test. Results indicate that more (44.11% and 60%) of pregnant women at Nsukka Health Centre and 40.54% and 55.55% of those attending Bishop Shanahan Hospital were dehydrated based on the urine specific gravity and serum osmolality, respectively. Respondents attending Medical Centre consumed more fluid (9559.83 mL) than 7734.86 mL for those at Nsukka Health Centre and 8786.43 mL for respondents at Bishop Shanahan Hospital. Majority of the respondents across the three hospitals perceived thatavailability of fluid and thirst sensation were the two most common determinants of their fluid intake.

Keywords: Hydration, Status, Fluid, Intake, Determinants, Pregnant, Women, Public, Hospitals.

Introduction

Water is a major constituent of the human body and it is essential for life. According to Song et al (2023) the human mass consists of 60 to 70 percent water and the blood containing about 83 percent of water. Water can be obtained from drinking plain water and beverages, water intake from food, and water produced by oxidative processes in the human body (*Senterre et al., 2014).* Studies have however shown that plain water is the largest source of fluids for pregnant women each day (Xie et al., 2022; Dilaver et al., 2024).

Pregnancy is a physiological period during which women's body experiences a

series of bodily changes to meet the needs for proper fetal growth and development. During pregnancy, an individual's water balance is affected by an increase in total body water content (Bardosono et al., 2016). Pregnant women need an additional 300 milliliters of fluid per day to support the physiological changes during pregnancy and fetal development (Tsakiridis et al., 2020). These changes include expansion of plasma volume, and continuous exchange of water between the developing fetus and its mother coupled with elevated adrenal and thyroid activity to accelerate metabolism which leads to increased perspiration and other alteration that encourage loss all increases the risk of dehydration (Song et al., 2023).

Optimum hydration during pregnancy is therefore very important. A recent study by Rosemiarti et al. (2022) shows that drinking extra quantity of water by pregnant women with oligohydramnios without maternal/fetal defects in the third trimester (28−37 weeks) can increase the amniotic fluid index (AFI) of pregnant women. They reported that oral maternal hydration ranging from 1,500 to 2,500 mL gave a better effect than intravenous maternal hydration on AFI. Dehydration occurs as a deficit in the water content of the body due to poor consumption or when water intake falls below losses.

Dehydration from preventable causes disproportionately affects the well-being of millions of people globally, particularly pregnant women who are considered as nutritionally vulnerable. Several studies have demonstrated that there is high prevalence of dehydration among pregnant women. Mulyani et al. (2017) reported that 57.1 percent of pregnant women experience dehydration in West Jakarta. In a study conducted at Uyo Metropolis, Southern Nigeria 14.6 percent of the pregnant women were dehydrated (Ekpenyong et al., 2020). A study carried out by Mulyani et al. (2021) in the area of Kebon Jeruk District Health Centre, West Jakarta found that 20 out of 38 pregnant women were dehydrated. In Greece, 34 percent of pregnant women were dehydrated, with rates increasing throughout pregnancy (Malisova et al., 2014).

While countries like the U.S.A and Indonesia provide specific fluid intake recommendations for pregnant women (300 mL/d, 2080 mL/d, respectively) *(Institute of Medicine, 2004; Ministry of Health of the Republic of Indonesia, 2013)*, Nigeria lacks such guidelines and this may potentially contribute to higher dehydration rates among pregnant women in Nigeria. There could be high prevalence of health risks among pregnant women attending public hospitals in Nsukka LGA considering similar studies in Nigeria settings. Ekpenyong et al. (2020) showed that 14.6 percent of pregnant women in Southern Nigeria were dehydrated. According these authors, inadequate water intake was the primary cause of dehydrated among these group of individuals.

Previous studies have found that a high proportion (55.9%) and 39.4 percent of pregnant women in Nsukka were anaemic due to low haemoglobin concentration of less than 11 g/dl while 27.6% were anaemic because they had low ferritin concentration which was below 15 µg/l (Eze et al., 2024; Uzoegbu et al., 2025). This may be related to inadequate hydration and nutritional practices (Eze et al., 2024). Socioeconomic and cultural

factors of pregnant women in Nsukka may expose them to dehydration. Studies have demonstrated that low income status coupled with having attended tertiary education correlated with dehydration and consumption of herbal concoctions which 40 percent of pregnant women in Nsukka engages in may displace water intake of these individuals (Ekpenyong et al. 2020; Dim et al. 2024).

In addition, there may be gaps in healthcare engagements. According to Adama et al. (2023) there is high prenatal care knowledge among pregnant women in Nsukka, while postnatal care engagement had been inconsistent indicating that there may be potential gaps in the holistic maternal health education including hydration. Again, lifestyle and dietary issues may be predisposing factors to dehydration. Studies by Ekpenyong et al. (2020) reported that consumption of high carbohydrate and/or protein diets increased the risk of dehydration by as high as 3.5 times and this may be relevant to Nsukka where dietary patterns are understudied. Similarly, Dim et al. (2024) found that 62.5 percent of Nsukka pregnant women reside in urban areas where certain lifestyle factors such as physical activities and water access may uniquely impact hydration. Besides, research on fluid intake and hydration status in pregnant Nigerian women is scarce. It was against this background that the present study seeks to compare the hydration status, fluid intake and determinants among pregnant women (23-35 years) attending public hospitals in Nsukka Local Government Area.

Objectives of the study

The broad objectives of this study was to examine the hydration status, fluid intake and its determinants among pregnant women (23-35 years) attending three public hospitals in Nsukka local government area (LGA). Specifically, the study determined:

1. hydration states of the respondents in the study area using different biomarkers (urine specific gravity and serum osmolality)
2. fluid intake (in volume) of the respondents
3. determinants of fluid intake of the respondents.

Methodology

***Design of the Study*:** A cross-sectional survey research design was adopted for the study.

***Area of the Study*:** This study was carried out in Nsukka LGA. It is one of the 17 LGAs in Enugu State, Nigeria. Farming crop and animal production constitute economic activities of inhabitants although, some of them engage in petty trading. Available data shows that it is difficult to obtain the exact number of public hospitals in Nsukka LGA. However, an estimated number shows that there are about 49 public health facilities in Nsukka LGA (Nsukka Local Government Area record, 2023).

***Population for the Study*:** The study population consisted of 310 registered healthy pregnant women between the age ranges of 20 to 35 years who attended three hospitals namely: Bishop Shanahan Hospital (BSH) 669, Medical Centre (MC) 117, and Nsukka Health Centre (NHC) 337, from the period of April to May 2023.

The number of registered pregnant women in BSH was 669, 117 MC and 337 for NHC (Bishop Shanahan Hospital Nurses' registration record, 2023; Medical Centre Nurses' Registration record, 2023; and Nsukka Health Centre Nurses' registration record, 2023). Data were obtained from records of each hospital/centre.

***Sample for the Study*:** The sample was made up of 86 pregnant women from the University Medical Centre, 113 from Nsukka Health Centre, and 111 from Bishop Shanahan Hospital, giving a total of 310 pregnant women. The sample size was determined using Cochran's formula. Convenience non-probability sampling technique was used to select the respondents from these three hospitals. The selection was based on the availability of respondents and their readiness to participate in the study.

***Instrument for Data Collection*:** Data for this study were collected using three instruments namely: the refractometer and serum osmolality, a 3-day fluid record questionnaire, and a 5-point Likert scale questionnaire. Refractometer and serum osmolality were used to obtain information on the hydration status of the respondents. The refractometer measure the urine specific gravity of the respondents as described by the University of Bristol (2017), serum osmolality determined the hydration of the participants by measuring the level of some solutes (sodium, glucose and blood urea nitrogen (BUN)) in the sample urine and then the values were calculated using the serum osmolality formula. A 3-day fluid record questionnaire was used to assess the fluid intake of the respondents. The fluid record contained questions on the type of fluid (water, hot beverages, soft drinks, energy drink etc.), size of the container in which the fluid was packaged, and time of consumption of the fluid (morning, mid-morning, afternoon, mid-afternoon, evening, mid-evening, and night). The 5-point scale questionnaire elicited information on determinants (cost, nutrition, availability, etc.) of fluid consumption among the respondents. The scale ranged from "strongly disagree" to "strongly agree". (Strongly disagree = 1, disagree = 2, undecided = 3, agree = 4, strongly agree = 5).

***Data Collection Techniques*:** Data were collected as follows: **U**rine specific gravity was determined using refractometer according to the University of Bristol (2017). The refractometer was cleaned by wiping the surface with a clean tissue and distilled water and two drops sample of urine was gently placed onto the reading surface using a clean syringe. Then the lid was closed and read through the eyepiece.

Serum osmolality was determined by measuring solutes (sodium, glucose and blood urea nitrogen {BUN). Values were calculated using the serum osmolality formula i.e., estimated osmolality (mOsm/kg) = 2 * Sodium (mEq/L) + Glucose (mg/dL)/18 + BUN (mg/dL)/2.8. The osmolality value was reported in milliosmoles per kilogram of water (mOsm/kg H_2O)

To determine sodium level, one mill of the sample was transferred into triplicate tubes and 2 ml of zinc uranyl acetate was added, mixed vigorously and allowed to stand for 5 minutes at room temperature. The mixture was centrifuged at 3000 g for five minutes and 2 ml of the supernatant was transferred to another tube followed

by addition of 8 ml of 1% acetic acid and 0.4 ml of 10% potassium ferricyanide and the absorbance was taken at 480 nm.

To determine glocuse level, reagents and samples were brought to room temperature and three clean tubes were prepared for the experiment. The reagents were mixed in the tubes and left for 5 minutes at 37^0C. Then the absorbance (A) of the sample and the standard was read as 500 nm against the reagent blank and finally, calculations were used to determine the concentration of glucose in the sample and compared with reference values.

To determine blood urea nitrogen, the reagents were mixed well and all placed in test tubes at the same time into vigorously boiling water bath and boil at exactly 15 minutes. It was cooled for 2-3 minutes in tap water and the absorbance value of unknown/control against reagent blank at 520 nm was read.

A total of 310 copies of the questionnaire were distributed to the respondents by hand with the help of trained research assistants. All the 310 copies were completed and retrieved. This represents 100 percent return.

***Statistical Analysis*:** Data collected were analyzed using mean, standard deviation, frequency, percentages, and Chi square at 0.05 level of significance.

Results

Hydration Status Based on USG and Serum Osmolality Biomarkers

Variable	BSHF (%)	MCF (%)	NHCF (%)	TotalF (%)
USG				
Euhydration	22(59.45)	15 (78.94)	19 (55.88)	56 (62.22)
Dehydration	15 (40.54)	4 (21.10)	15 (44.11)	34 (37.77)
Total	**37 (100)**	**19 (100)**	**34 (100)**	**90 (100)**
χ^2 = 2.963, df =2, p = 0.227				
Serum osmolality				
Euhydration	4 (44.44)	5 (62.50)	6 (40.00)	15 (46.87)
Dehydration	5 (55.55)	3 (37.50)	9 (60.00)	17 (53.12)
Total	**9 (100)**	**8 (100)**	**15 (100)**	**32 (100)**
χ^2 = 1.090, df = 2, p = 0.580				

BSH = Bishop Shanahan Hospital, MC = Medical Centre, NHC = Nsukka Health Centre, F = frequency, % = percentage, χ^2 = chi-square, df = degree of freedom, p = level of significance, Euhydration = USG < 1.020, Dehydration = UGS > 1.020.

Table 1 shows the hydration status of the respondents based on USG and serum osmolality biomarkers. The results show that more of the respondents who attended BSH (59.45% and 55.55%) and NHC (55.88% and 60.00%) were dehydrated while those that attended MC were more euhydrated (78.94% and 62.50%) using both USG and serum osmolality criteria, respectively. However, there was no significant difference in terms of the amount of fluid consumed by the respondents in the three public hospitals.

Table 2: Average Daily Fluid and Contribution of Water and Beverage to the Total Fluid Intake of Respondents by Hospital

Variable	$\bar{x_1}$ ±SD	$\bar{x_2}$±SD	$\bar{x_3}$ ±SD
Total fluid intake (mL)	8786.43±2750.06	9559.83±2614.16	7734.86±2094.41
Total water intake (mL)	7837.29±2473.39	8339.54±2371.45	6904.86±1888.03
Total beverage intake (mL)	949.14±557.84	1220.29±713.21	830.00±495.05
Percentage water intake (%)	89.52	87.17	89.51
Percentage beverage intake (%)	10.48	12.83	10.49

BSH = Bishop Shanahan Hospital (70), MC = Medical Centre (86), NHC = Nsukka Health Centre (72), SD = standard deviation, % = percentage; $\bar{x_1}$ *= BSH mean;* $\bar{x_2}$ *=MC mean;* $\bar{x_3}$ *= NHC mean*

Table 1 shows the total daily fluid intake, contribution of water and beverage to the total fluid consumption of respondents by hospitals. The mean total fluid intake of the respondents illustrates that those attending MC consumed higher (9559.83 mL) fluid compared to their counterparts attending BSH (8786.43 mL) and NHC (7734.86 mL). Water was the major source of fluid for the respondents across the three hospitals and it contributed 89.52%, 87.17% and 89.51% of the total fluid consumed by respondents attending BSH, MC and NHC, respectively.

Table 3: Mean Responses on Determinants of Fluid Intake of the Respondents

S/N	Determinants	$\bar{X}_1$	$\bar{X}_2$	$\bar{X}_3$
1	Cost	3.18	3.30	3.29
2	Nutrition	3.06	3.08	3.57
3	Availability of fluid	3.26	3.55	3.48
4	Perceived health benefit	3.20	3.28	3.61
5	Physical activity	3.32	3.25	3.09
6	Thirst	4.00	3.85	3.48
7	Environmental condition	3.19	3.28	3.26
8	Sickness	2.91	3.09	3.15
9	Medication	2.67	3.09	2.88
10	Clothing	2.78	2.60	3.04

$\bar{x_1}$ = BSH mean; $\bar{x_2}$ = MC mean; $\bar{x_3}$ = NHC mean; ***Weighted average =3.23***

Table 2 shows the determinants of fluid intake of the respondents. The statistical analysis shows that majority of the respondents attending BSH, MC and NHC highly perceived thatavailability of fluid and thirst sensation made them to drink fluid. More of the respondents attending MC and NHC had high perception that cost and perceived health benefit influenced their drinking behavour whereas those attending BSH and NHC highly perceived that the effect of physical activity applied to the manner with which they drink fluids. On the contrary, most of the respondents attending BSH, MC and NHC had low perception that sickness, medication and clothing affected the way they consumed fluids.

Discussion

More of the respondents from NHC and BSH were dehydrated based on both urine specific gravity and serum osmolality criteria than those attending MC (Table 1). This indicted that none of the two biomarkers was more sensitive than the other. The result of the present study was in line with an earlier study among pregnant women where more than 50

percent of overweight and obese pregnant women in America were dehydrated (Rosinger et al., 2022). Again, Mulyani et al. (2021) in the area of Kebon Jeruk District Health Centre, West Jakarta found that 20 out of 38 pregnant women were dehydrated. In Greece, 34 percent of pregnant women were dehydrated, with rates increasing throughout pregnancy (Malisova et al., 2014). In contrast, this study was difference from the study by Ekpenyong, et al., (2020) in Uyo Metropolis, Southern Nigeria where 14.6 percent of the pregnant women were dehydrated.

The fluid consumption of the pregnant women in the current study was not adequate and agrees with the study by Song et al. (2023) where 100.0%, 97.2%, and 85.2% of Chinese pregnant women did not consume the recommended amount of fluid in the first, second and third trimesters. Dilaver et al. (2024) found that daily fluid intake of 557 (51.5%) of pregnant women was insufficient.

Water constituted the major type of fluid consumed by the respondents in the current study. The result of the present research was in concordance with the study of Xie et al. (2022) where the median daily water intake of pregnant women was 1321 mL and plain water contributed the highest amount (1000 mL) of all the fluid consumed. Xie et al. (2023) also found the mean total fluid intake (TFI) of pregnant women to be 1970 mL, with plain water contributing to 68.7% of the fluid consumed. Dilaver et al (2024) found that pregnant women obtained 78.8% of their fluid from plain water. Conversely, a similar research in Mexico shows that the mean total fluid intake of pregnant women was 2.62 L/day with sugar sweetened beverage contributing significantly more (38%) than the plain water (33%) (Martinez, 2014). Additionally, studies by Song et al. (2023) reported that plain water accounted for 92.0%, 94.2%, and 93.4% of daily fluid intake of pregnant women in the first, second, and third trimesters, respectively in China. Higher intake of plain water across all the three hospitals was expected because water is always available for individuals than beverages.

Generally, majority of the respondents across the three hospitals had high perception that thirst and availability of fluid were the most two common factors that influence the amount and frequency of fluid consumed they consumed. However, most of the respondents attending BSH, MC and NHC had low perception that sickness, medication and clothing affected the way and frequency of fluid consumed.

Conclusion

This study revealed that there was moderate dehydration among the pregnant women in the study area due to suboptimal consumption of fluids. Thirst and availability of fluid were the most common factors identified to affect the amount of fluid consumed by the respondents and sickness, medication and wearing of various kinds of clothing were the factors that lest influenced their fluid intake.

Recommendations

1. Further study could be carried out on the fluid contribution from food to ascertain the actual reason behind the high prevalence of dehydration among these pregnant women.

2. Further studies could also focus on a particular trimester of pregnancy in order to identify the stage of pregnancy when dehydration was highest.
3. Pregnant women in the study area should drink adequate amount of water to prevent dehydration
4. Government should incorporate health programmes that would help the community health providers to teach and encourage pregnant women to consume enough fluids to reduce dehydration and its complications.

References

Adama, G.N., Nweke, P.O & Okeke, N.M. (2023). Knowledge and practice of the safe motherhood initiative among childbearing mothers attending many clinics in the Nsukka health district. International Journal of Studies in Education, 19(3), December, 2023, 92-102

Bardosono, S., Prasmusinto, D., Hadiati, D. R., Purwaka, B. T., Morin, C., Pohan, R., Sunardi, D., Chandra, D. N., & Guelinckx, I. (2016). Fluid Intake of Pregnant and Breastfeeding Women in Indonesia: A Cross-Sectional Survey with a Seven-Day Fluid Specific Record. *Nutrients*, 8(11), 651. https://doi.org/10.3390/nu8110651

Dilaver, I., Somuncu, B.P., Topbas, M. Sahin, K., Ustundag, M.G. Gundogmus, C.A. Can, G., & Beyhun, N.E. (2024). Analysis of Fluid Intake during Pregnancy. *Makara Journal of Health Research*, 28(2):106−113 doi: 10.7454/msk.v28i2.1648

Dim, O.F., Anene-Okeke, C.G., & Ukwe, C.V. (2024). Knowledge, attitude and use of herbal medicine among pregnant women attending antenatal care in Nsukka, Nigeria. African Health Sciences, 24(4), 182-191 Doi: 10.4314/Ahs.V24i4.24

Ekpenyong, C.E., Udokang, N.E., & Inyang, C.A. (2020). Prevalence and associated risk factors of dehydration among pregnant women in Southern Nigeria. *Journal of Advances in Medicine and Medical Research,* 10-23. DOI: 10.9734/jammr/2020/v32i730444

Eze, S. N., Ani, P.N., & Anoshirike, C. O. (2024). Anaemia in pregnancy: prevalence and associated socio-demographic and obstetric factors in urban and rural communities in Nsukka area of Enugu State, Nigeria. *African Health Sciences,* 24(2), 194-202. https://dx.doi.org/10.4314/ahs.v24i2.22

Institute of Medicine. Food and Nutrition Board. Dietary Reference Intakes for Water, Potassium, Sodium, Chloride and Sulfate. National Academies Press; Washington, DC, USA: 2004

Malisova, O., Athanasios, P., Anastasia, N., Vassiliki, B., Aristides, A., Antonis, Z., & dan Maria, K. (2014). Estimations of water balance after validating and administering the water balance questionnaire in pregnant women. *International Journal of Food Science and Nutrition,* 65(3):280-285

Martinez, H. (2014). Fluid consumption by Mexican women during pregnancy and first semester of lactation. *BioMed Research International*, 603282. https://doi.org/10.1155 /2014/603282

Ministry of Health of the Republic of Indonesia (2013). *Recommended Nutritional Intake for Indonesian Population.* Ministry of Health; Jakarta, Indonesia.

Mulyani, E.Y., Hardinsyah, B.D., Santoso, B.I, & Jus'at, I. (2017). Effect of dehydration during pregnancy on birth weight and length in West Jakarta. *Journal of Nutritional Science*, 10, e70. doi: 10.1017/jns.2021.59. PMID: 34527228; PMCID: PMC8411261.

Mulyani, E.Y., Hardinsyah, Briawan, D & Santoso, B. I. (2021). Hydration status of pregnant women in West Jakarta. *Asia Pacific Journal of Clinical Nutrition*, 26(1):S26-S30

Nsukka Local Government Area Health Record (2023). Oral communication.

Retrieved from Bishop Shanahan Hospital Nurses' registration record (2023) on 10th June, 2023.

Retrieved from Medical Centre Nurses' Registration record (2023) on 31st May 2023.

Retrieved from Nsukka Health Centre Nurses' registration record (2023) on 2nd June, 2023.

Rosemiarti, T., Siregar, P., Hardinsyah, H., Pardede, S.O. Santoso, B I., Riza, R A., & Tjahjono, F. (2022). An Additional Adequate Water Intake Increases the Amniotic Fluid Index in Pregnant Women with Oligohydramnios: A Systematic Review. *Indonesian Journal of Nutrition and Food,* 17(1):47-56 DOI: https://doi.org/10.25182/jgp.2022.17.1.47-56

Rosinger, A.Y.; Bethancourt, H.J.; Pauley, A.M.; Latona, C.; John, J.; Kelyman, A.; Leonard, K.S.; Hohman, E.E.; McNitt, K.; Gernand, A.D.; et al. (2022). Variation in urine osmolality throughout pregnancy: A longitudinal, randomized-control trial among women with overweight and obesity. *European. Journal of Nutrition, 61*, 127–140.

Senterre, C., Dramaix, M., & Thiébaut, I. (2014). Fluid intake survey among schoolchildren in Belgium. *BMC Public Health*, 14, 651.

Song, Y., Zhang, F., Wang, X., Lin, G., He, L., Lin, Z., Zhang, N., & Ma, G. (2023). The Amount of Fluid Intake among Pregnant Women in China Increases with Pregnancy Progression: A Prospective Cohort Study. *Nutrients*, 15(22), 4720. doi: 10.3390/nu15224720. PMID: 38004114; PMCID: PMC10675010.

Tsakiridis, I., Kasapidou, E., Dagklis, T., Leonida, I., Leonida, C., Bakaloudi, D.R., & Chourdakis, M (2020). Nutrition in Pregnancy: A Comparative Review of Major Guidelines. *Obstetrical & Gynecological Survey*, 75, 692-702.

University of Bristol (2017). Measuring Total Solids (Total Proteins) using a Refractometer.

Uzoegbu, K.C., Okoroh, P.N., Anakor, D.O., Uzuegbu, I.E., Ekeke, K.L., Osuji, C.A (2025). Iron status of pregnant women at Nsukka, Enugu State, South East Nigeria. *International Journal of Biochemistry Research and Review*, 34(1), 33-41

Xie, Z ., Lin X, Lu X, Teng, Y, Dai N, Wang, F, Guo, J, Ding, Y, Wu, J., &Wang, Z. (2022). [Water intake and its influence factors among pregnant and lactating women in some areas of China in 2020]. Wei Sheng yan jiu = *Journal of Hygiene Research*. 51(3), 367-373. DOI: 10.19813/j.cnki.weishengyanjiu.2022.03.004. PMID: 35718896

Xie, Z., Li, X., Li, G., Lu, X., Wu, J., Lin, X., Yang, Y., Shi, X., Ding, Y., & Wang, Z. (2023). Water Intake and Hydration Status among Pregnant Women in the Second Trimester in China: A Three-Day Metabolic Trial. *Nutrients*, *16*(1), 116. https://doi.org/10.3390/nu16010116