

Risk factors for inadequate gestational weight gain: preliminary findings from the LIMIT prospective cohort study

Alemayohu Mulubirhan Assefa¹, Loperfido Federica², Monti Maria Cristina¹, Sottotetti Francesca², El Masri Dana², Bianco Irene², Ferrara Chiara², Cerbo Rosa Maria³, Civardi Elisa³, Garofoli Francesca³, Angelini Micol³, Maccarini Beatrice², Ghirardello Stefano³, Simona Villani¹, Cena Hellas^{2,4} and De Giuseppe Rachele²

¹ Biostatistics and Clinical Epidemiology Unit, Department of Public Health, Experimental and Forensic Medicine, University of Pavia, 27100 Pavia, Italy

² Laboratory of Dietetics and Clinical Nutrition, Department of Public Health, Experimental and Forensic Medicine, University of Pavia, Via Bassi 21, 27100 Pavia, Italy

³ Neonatal Unit and Neonatal Intensive Care Unit, Fondazione IRCCS Policlinico San Matteo, 27100 Pavia, Italy

⁴ Clinical Nutrition and Dietetics Service, Unit of Internal Medicine and Endocrinology, ICS Maugeri IRCCS, 27100 Pavia, Italy

Introduction: Weight gain during pregnancy is a fundamental antenatal factor since falling outside, either above or below, exposes women and their infants to increased health risks. Inadequate gestational weight gain (GWG) can lead to the presence of unfavourable gestational outcomes and threaten long-term maternal and child health. For instance, women who gain more than the recommended amount of weight during pregnancy have greater postpartum weight retention, resulting in a higher incidence of postpartum obesity and a greater likelihood of entering subsequent pregnancies with extra weight, thus exposing themselves and the foetus to delivery complications, caesarean delivery, and obesity during childhood. On the other side, gaining less than the recommended amount of weight in pregnancy is associated with a higher incidence of small for gestational age.

Pre-pregnancy and gestational lifestyle intervention can help GWG management; indeed, it has been previously demonstrated that dietary habits, such as adherence to the Mediterranean Diet (MD), influence specific maternal and infant parameters. Thus, optimizing GWG has been advocated as a public health strategy to promote maternal and newborn health.

Objective. The present research aimed to explore lifestyle factors associated with inadequate gestational gain, paying particular attention to dietary habits.

Methods: This cross-sectional analysis uses data from the ongoing prospective cohort study named LIMIT (Lifestyle and Microbiome InTeraction) Early Adiposity Rebound in Children [4] and evaluates socio-demographic variables, pre-pregnancy (weight, Kg; height, cm and Body Mass Index, Kg/m²) ponderal status and gestational lifestyle factors (MD adherence, physical activity level and smoking habits) at baseline in relation to the GWG [4]. 131 women enrolled during the pre-hospital care before birth at the UOC Neonatology and Neonatal Intensive Care, Fondazione IRCCS Policlinico San Matteo of Pavia, were considered, according to inclusion/exclusion criteria previously described [4]. Based on the IOM Pregnancy Weight Guidelines [5] they were divided into women with i). adequate gestational gain (AGWG); ii) excessive gestational weight gain (EGWG); iii) low gestational weight gain (LGWG). Adherence to MD was assessed using the MEDI-LITE score obtained from a questionnaire previously validated by Sofi et al. 2017 [6]. The questionnaire investigates the frequency of consumption of nine classes of food; the score obtained from the questionnaire ranges from 0 to 18, where the highest value corresponds to the highest MD adherence (cut-off \geq 9) [6]. Particularly, for the present preliminary investigation, each item of the questionnaire was also considered separately. Physical activity level was investigated using a section of a questionnaire previously validated by Turconi et al. 2003, consisting of 5 items following response categories: always, often, sometimes, and never. The score assigned to each response ranged from 0 to 3, with the maximum score assigned to the healthiest habit and the minimum score to the least healthy [7]. Smoking habits and educational level were also investigated. A descriptive analysis of the baseline data collection was performed, followed by their comparison by GWG status (AGWG, EGWG and LGWG groups). The normal distribution of continuous variables was tested using the Shapiro-Wilk W-test, and the Kruskal-Wallis test or

ANOVA were used, as appropriate. Chi-square or Fisher exact tests were applied for the comparison of categorical variables. Variables with a significantly different distribution among GWG groups (p-value less than 0.1) were selected for the multinomial logistic regression model, which was used to identify risk factors associated with inadequate GWG. The forest plot has been used to present the adjusted relative risk ratio (RRR) and 95%CI for each predictor, considering, respectively, EGWG vs AGWG and LGVG vs AGWG outcome categories (AGVG is the reference category).

Results: A total of 104 pregnant women were eligible for this analysis. The mean total GWG and age were 12 ± 4.2 kg and 33.5 ± 4.4 years, respectively. Inadequate GWG was estimated at 47.1% and of this, 31 (29.8%) of the pregnant women had LGWG, while 18 (17.8%) had EGWG. More than 55% of the pregnant women with EGWG had a pre-pregnancy BMI indicative of overweight or obesity, while 26 (83.9%) of the pregnant women with LGWG had a normal pregravid BMI. Six out of ten women reported adherence to MD, accounting for 64.4%, with no significant differences according to the adequacy of GWG. The physical activity mean score based on the Turconi et al. questionnaire was high among pregnant women with AGWG compared to those with EGWG. In the univariate analysis, pregravid BMI ($p < 0.001$), maternal education level ($p = 0.019$), physical activity mean score ($p = 0.012$), daily consumption of vegetables ($p = 0.001$), and daily consumption of milk and milk products ($p = 0.013$) were differently distributed among GWG groups. In the multivariate regression, pregravid BMI (RRR= 1.24, $p = 0.008$), physical activity mean score (RRR=0.78, $p = 0.036$), and daily consumption of 1-1.5 portions of milk and milk products (RRR=0.05, $p = 0.014$) were strongly associated with EGWG compared to AGWG while daily fair vegetable consumption was significantly associated with LGWG (RRR=14.6, $p = 0.038$) compared to AGWG (Figure 1).

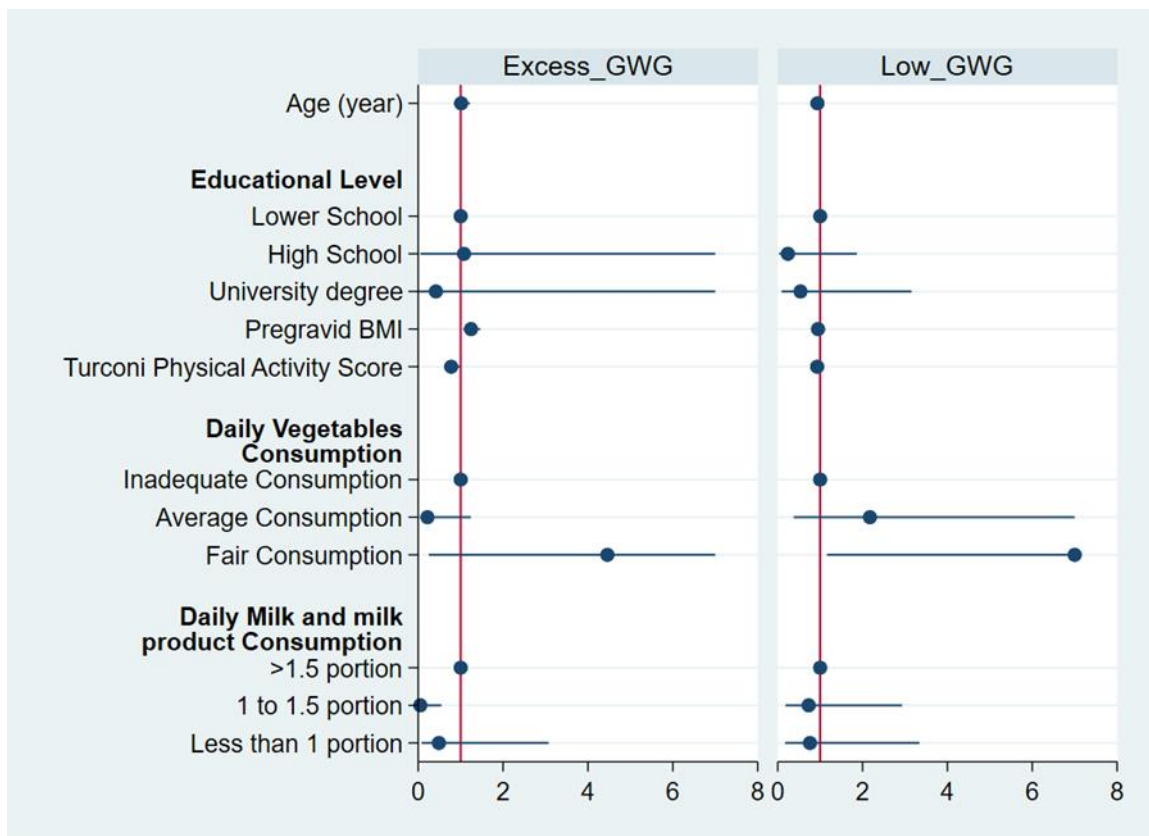


Figure 1. Forest plot showing the results of the multinomial regression model using baseline data from the LIMIT prospective cohort study. Predictor's relative risk ratio and corresponding confidence intervals for

Excess and Low GWG are reported considering adequate gestational weight gain (AGWG) as the reference level of the outcome.

Conclusions. The preliminary findings from LIMIT show alarming inadequate GWG among pregnant women. This study supports the evidence that gestational weight gain is partially explained by pre-pregnancy BMI, gestational dietary habits, and physical activity level. Thus, promoting an adequate lifestyle, in childbearing age and during pregnancy is a primary prevention instrument of fundamental importance that promotes both maternal and infant health.

Funding: This project was funded under the National Recovery and Resilience Plan (NRRP), Mission 4, Component 2, Investment 1.3—Call for proposals No. 341 of 15 March 2022 of the Italian Ministry of Universities and Research funded by the European Union's Next Generation EU. Project code PE00000003, Concession Decree No. 1550 of 11 October 2022, adopted by the Italian Ministry of Universities and Research, CUP D93C22000890001, project title "ON Foods—Research and innovation network for food and nutrition sustainability, safety and security—Working ON Foods".

Bibliography

1. Harrison C.L., Bahri Khomami M., Enticott J., et al. Components of Antenatal Lifestyle Interventions to Optimize Gestational Weight Gain: Secondary Analysis of a Systematic Review. *JAMA Netw Open.* 2023;6(6):e2318031. Published 2023 Jun 1. doi:10.1001/jamanetworkopen.2023.18031
2. Adamo K.B., Semeniuk K., da Silva D.F., et al. SmartMoms Canada: An evaluation of a mobile app intervention to support a healthy pregnancy. *Contemp Clin Trials.* 2023;126:107066. doi:10.1016/j.cct.2022.107066
3. Di Renzo L, Marchetti M, Rizzo G, et al. Adherence to Mediterranean Diet and Its Association with Maternal and Newborn Outcomes. *Int J Environ Res Public Health.* 2022;19(14):8497. Published 2022 Jul 12. doi:10.3390/ijerph19148497
4. De Giuseppe R, Loperfido F, Cerbo RM, et al. *LIMIT: Lifestyle and Microbiome Interaction Early Adiposity Rebound in Children, a Study Protocol* 2022;12(9):809. doi 10.3390/metabo12090809.
5. Rasmussen KM, Yaktine AL, Institute of Medicine (US), National Research Council (US) *Weight Gain During Pregnancy: Reexamining the Guidelines.* Washington, D.C.: National Academies Press; 2009.
6. Sofi, F.; Dinu, M.; Pagliai, G.; Marcucci, R.; Casini, A. Validation of a literature-based adherence score to Mediterranean diet: The MEDI-LITE score. *Int. J. Food Sci. Nutr.* 2017, 68, 757–762.
7. Turconi, G.; Celsa, M.; Rezzani, C.; Biino, G.; Sartirana, M.A.; Roggi, C. Reliability of a dietary questionnaire on food habits, eating behaviour and nutritional knowledge of adolescents. *Eur. J. Clin. Nutr.* 2003, 57, 753–763.