**APPENDIX:1**

TITLE: The cost-effectiveness of nutritional supplementation for perinatal women on infant outcomes: a dynamic microsimulation

RE: Meta-analysis of maternal BMI and infant birthweight

The mean difference in infant birthweight between underweight mothers (pre-pregnancy BMI <18.5 kg/m2) and non-underweight mothers was used to model the effect between maternal nourishment status and infant birthweight. A systematic review by Yu et al in 2013 reported the odds ratios of low birthweight (birthweight <2500g) by maternal BMI status compared with non-underweight mothers: pre-pregnancy underweight increased the risk of low birthweight by an OR of 1.47 (95% UI:1.27–1.71)1. We reviewed the studies in the Yu et al 2013 meta-analysis to obtain studies that reported mean birthweight by maternal nourishment category. We conducted an additional literature search on Google Scholar and PubMed for studies using the search terms [“maternal underweight” OR “pre-pregnancy BMI”] AND “birth outcomes”. We included papers that reported mean birthweight differences between underweight women with BMI below <18.5 kg/m2 and non-underweight women with BMI ≥18.5 kg/m2. If more than one ‘non-low’ birthweight groups were reported, the mean birthweight of the non-low birthweight groups was the weighted average of all sub-groups. We pooled the mean difference in birthweight using a random effects model in STATA 14 to obtain an effect of **-147.71 (-210.9 to -84.52).** BMI groupings are according to WHO standard unless otherwise specified: underweight <18.5kg/m2; normal weight ≥18.5kg/m2 to <25kg/m2; overweight ≥18.5kg/m2 to <25kg/m2;obese ≥18.5kg/m2 to <25kg/m2.

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| **Table 1: Pre-pregnancy BMI groupings and mean birthweight by studies included** | | | | | | | | |
| **Study** | **Location** | **BMI groupings** | **N (%)** | **Mean (SD)** | **low maternal BMI** | | **‘non-low’ maternal BMI** | |
| **N** | **Mean (SD)** | **N** | **Mean (SD)** |
| Kalk 20092 | Berlin, Germany | a. underweight  b. normal weight  c. overweight  d. obese | 163 (8%)  1446 (71%)  309 (15%)  126 (6%) | 3210 (668)  3347 (608)  3453 (644)  3587 (618) | 163 | 3210 (668) | 1881 | 3380 (614) |
| Koepp3  2011 | Norway | a. underweight  b. normal weight  c. overweight  d. obese I  e. obese II  f. obese III | 1710 (2.9%)  38,063 (65.2%)  13,010 (22.3%)  4094 (7%)  1138 (1.9%)  368 (0.6%) | 3418† (684)  3637† (727)  3756† (751)  3811† (762)  3860† (772)  3906† (781) | 1710 | 3418(684) | 56,673 | 3683 (737) |
| Jeric 20124 | Split, Croatia | 1. underweight 2. normal weight 3. overweight 4. obese | 351 (7.5%)  3688 (78.8%)  550 (11.8%)  89 (1.9%) | 3343 (428)  3511 (48)  3698 (492)  3751 (509) | 351 | 3343 (428) | 4327 | 3540 (113) |
| Sharifzadeh 20155 | Tehran, Iran | 1. underweight 2. normal weight 3. overweight 4. obese | 21 (5.3%)  198 (50%)  117 (29.5%)  60 (15.2%) | 2808 (648)  2924 (594)  3026 (742)  3265 (585) | 21 | 2808 (648) | 375 | 3010 (639) |
| Xiao 20176 | Shanghai, China | 1. underweight 2. normal weight¶ 3. overweight and obese¶ | 120 (23.5%)  336 (65.9%)  54 (10.6%) | 3268 (368)  3390 (465)  3536 (448) | 120 | 3268 (336) | 390 | 3410 (462) |
| Soltani 20177 | Western Sumatra, Indonesia | 1. underweight 2. normal weight 3. overweight 4. obese | 107 (20.1%)  347 (65.2%)  72 (13.5%)  6 (1.1%) | 3140 (370)  3159 (382)  3222 (479)  3683 (519) | 107 | 3140 (370) | 425 | 3177 (400) |
| Gondwe 20188 | Semi-urban/ semi-rural area of southern Malawi | 1. underweight 2. normal weight 3. overweight\* | 62 (5%)  941 (83%)  133 (12%) | 2939 (447)  2973 (447)  3012 (440) | 62 | 2939 (447) | 1074 | 2978 (446) |
| Nowak 20199 | Cracow, Poland | 1. underweight 2. normal weight 3. overweight 4. obese | 43 (9%)  313 (66%)  91 (19%)  27 (6%) | 3197 (455)  3294 (545)  3383 (581)  3368 (760) | 43 | 3197 (455) | 431 | 3317 (566) |
| Bhowmik 201910 | Daka city, Bangledesh | 1. underweight 2. normal weightµ 3. overweightµ | 38 (27.5%)  67 (48.6%)  33 (23.9%) | 2700 (400)  2800 (400)  2900 (400) | 38 | 2700 (400) | 100 | 2833 (400) |
| \*BMI ≥ 25.0 kg/m2  obese class I = 30.0–34.9; obese class II = 35.0–39.9, obese class III *>*40.0  † SD approximated as +/- 20% of mean  ¶ women were divided into four groups based on pre-pregnancy BMI according to categories defined by the Working Group on  Obesity in China as follows: underweight (BMI < 18.5 kg/m2), normal weight (18.5 kg/m2 ≤ BMI < 24.0 kg/m2),  overweight (24.0 kg/m2 ≤ BMI < 28.0 kg/m2), and obese (BMI ≥ 28.0 kg/m2)  µ Normal weight (BMI 18.5- to < 23 kg/m2) and overweight (BMI ≥ 23 kg/m2) according to the Asian pre-pregnancy categories | | | | | | | | |

Table 2 shows the distribution of weight among women in the modelled countries. Maternal underweight ranges from 8.5% to 22.9% whereas maternal overweight and obese ranges from 20.7% to 52.2%.

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| **Table 2: Distribution of weight among women in India, Pakistan, Mali and Tanzania from most recent Demographic Health Survey** | | | | | | |
| Country | Survey | Underweight women with BMI (<18.5) | Normal weight women with BMI (18.5-24.9) | Overweight women with BMI (25.0-29.9) | Obese women with BMI (>=30.0) | Overweight and obese women with BMI (>=25.0) |
| India | 2015-16 DHS | 22.9% | 56.4% | 15.5% | 5.1% | 20.7% |
| Pakistan | 2017-18 DHS | 8.5% | 39.3% | 30.4% | 21.8% | 52.2% |
| Mali | 2018 DHS | 10.3% | 61.9% | 19% | 8.7% | 27.8% |
| Tanzania | 2015-16 DHS | 9.5% | 62.1% | 18.4% | 10% | 28.4% |

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| **Figure 1: Forest plot of the association between pre-pregnancy BMI and low birthweight (9 studies)** |
| C:\Users\Nicoly\Dropbox\IHME\BMI_meta_102020.JPG |

**References**

1 Yu Z, Han S, Zhu J, Sun X, Ji C, Guo X. Pre-Pregnancy Body Mass Index in Relation to Infant Birth Weight and Offspring Overweight/Obesity: A Systematic Review and Meta-Analysis. *PLoS ONE* 2013; **8**. DOI:10.1371/journal.pone.0061627.

2 Kalk P, Guthmann F, Krause K, *et al.* Impact of maternal body mass index on neonatal outcome. *Eur J Med Res* 2009; **14**: 216.

3 Koepp UMS, Andersen LF, Dahl‐Joergensen K, Stigum H, Nass O, Nystad W. Maternal pre-pregnant body mass index, maternal weight change and offspring birthweight. *Acta Obstet Gynecol Scand* 2012; **91**: 243–9.

4 Jeric M, Roje D, Medic N, Strinic T, Mestrovic Z, Vulic M. Maternal pre-pregnancy underweight and fetal growth in relation to institute of medicine recommendations for gestational weight gain. *Early Hum Dev* 2013; **89**: 277–81.

5 Sharifzadeh F, Kashanian M, Jouhari S, Sheikhansari N. Relationship between pre-pregnancy maternal BMI with spontaneous preterm delivery and birth weight. *J Obstet Gynaecol* 2015; **35**: 354–7.

6 Xiao L, Ding G, Vinturache A, *et al.* Associations of maternal pre-pregnancy body mass index and gestational weight gain with birth outcomes in Shanghai, China. *Sci Rep* 2017; **7**: 1–8.

7 Soltani H, Lipoeto NI, Fair FJ, Kilner K, Yusrawati Y. Pre-pregnancy body mass index and gestational weight gain and their effects on pregnancy and birth outcomes: a cohort study in West Sumatra, Indonesia. *BMC Womens Health* 2017; **17**. DOI:10.1186/s12905-017-0455-2.

8 Gondwe A, Ashorn P, Ashorn U, *et al.* Pre-pregnancy body mass index (BMI) and maternal gestational weight gain are positively associated with birth outcomes in rural Malawi. *PLOS ONE* 2018; **13**: e0206035.

9 Nowak M, Kalwa M, Oleksy P, Marszalek K, Radon-Pokracka M, Huras H. The relationship between pre-pregnancy BMI, gestational weight gain and neonatal birth weight: a retrospective cohort study. *Ginekol Pol* 2019; **90**: 50–4.

10 Bhowmik B, Siddique T, Majumder A, *et al.* Maternal BMI and nutritional status in early pregnancy and its impact on neonatal outcomes at birth in Bangladesh. *BMC Pregnancy Childbirth* 2019; **19**. DOI:10.1186/s12884-019-2571-5.