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1 **Probability of myopia in children with high refined carbohydrates**
2 **consumption in France**

3

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23

24 **Abstract**

25 **Background:** Evaluate risk factors for paediatric myopia in a contemporary French cohort taking into
26 account consumption of refined carbohydrates (starches and sugars).

27 **Methods:** An epidemiological cross-sectional study was conducted between May 2017 and May 2018.
28 264 children aged 4 to 18 years attending the Centre Hospitalier Universitaire Gui de Chauliac in
29 Montpellier were recruited. Ophthalmologic or optometric cycloplegic refraction were measured.
30 Evaluated risk factors for myopia were collected, including family history of myopia, outdoor time,
31 reading time, screen time, physical activity, and consumption of refined carbohydrates. Association
32 between the probability of at least one eye showing myopia (defined as < 0 D) and frequency of refined
33 carbohydrates consumption adjusted for risk factors and control factors was tested.

34 **Results:** Overall, 86/264 (32.6%) children investigated showed myopia in at least one eye. We included
35 180 children exhibiting refraction < 3 D in both eyes: 88 (48.9%) girls and 92 (51.1%) boys. The
36 consumption of refined carbohydrates significantly increased the probability of myopia for girls (odds
37 ratio [OR]=1.07; 95% confidence interval [CI], 1.02–1.13; $P=0.009$) but decreased it for boys
38 (OR=0.94; 95% CI, 0.89–0.98; $P=0.011$). The probability of myopia was marginally increased with
39 increased screen time (OR=2.32; 95% CI, 0.94–6.47; $P=0.083$). Outdoor time seemed marginally
40 protective (OR=0.74; 95% CI, 0.54–1.01; $P=0.057$).

41 **Conclusion:** Refined carbohydrates consumption could be associated with child myopia, with
42 increased probability for girls and unexpected reduced probability for boys, possibly due to the fact that
43 frequency of carbohydrates consumption do not really capture boy's chronic hyperglycemia, boys being
44 more physically active than girls at all ages. Some known risk/protective factors of myopia were
45 marginally significant: screen time (risk) and outdoor time (protective). This study reinforces the belief
46 that modifiable risk factors for myopia could be targets for future public health actions.

47 **Key words:** myopia, risk factors, diet, refined carbohydrates, sugar, starch, screen time, outdoor time,
48 children

49

50 **Background**

51 Myopia is a multifactorial refractive disorder characterised by blurry distance vision with eyes
52 displaying steeper corneal curvature and/or longer axial length as compared with emmetropes [1]. High
53 myopia (usually defined as < -6 D) is a risk factor for potentially blinding complications such as retinal
54 detachment, subretinal neovascularisation, early cataract and glaucoma [2].

55 Myopia has become a significant public health problem, with a substantial increase in
56 prevalence worldwide [3]. For example, in China, the proportion of people with myopia increased from
57 20% in the 1970s to 90% in 2018 [4]. In 2010, 28% of the world's population was myopic and a group
58 of world health experts projected that with the current trends, half of the world's population will be
59 affected by myopia in 2050 [5].

60 With the fast time-scale increase in myopia (less than 2 to 3 generations), non-genetic
61 associated factors are being identified [6, 7]. Time spent doing close eye work (near-work), duration of
62 study time and level of education are most frequently cited as the main environmental factors
63 underlying the development of myopia[8–10]. Outdoor time (exposure to natural light) but not physical
64 activity is described as a protective factor because children spending more time outside show less
65 incidence of myopia [11–13]. To control for genetic variability, Ramessuret et al. (2015) compared
66 refractions in several pairs of homozygous twins and showed that the most myopic twin was the one
67 who spent the least time outside [14].

68 Other possible factors were previously proposed, but were later discarded. For example, in
69 1956, Gardiner suggested dietary involvement in the pathophysiology of myopia: a comparison of the
70 diet of 33 active myopic and 251 stable myopic individuals showed increased consumption of lipids
71 and carbohydrates in the active group [15]. Almost 2 decades ago, Cordain et al. (2002) first proposed
72 that via hyperinsulinism, consumption of refined carbohydrates (starches and sugars) could be involved
73 in the development of juvenile-onset myopia: the interaction between hyperinsulinism and hormonal
74 regulation of eye growth could increase the elongation of the axial eyeball [16]. This hypothesis has
75 been supported by more recent evidence [17–23]. Of note, the dietary hypothesis and the near-work
76 hypothesis cannot be tested independently, because the type and quantity of diet is associated with
77 physical activities, which may be negatively correlated with time spent on near-work [24–26]. To our
78 knowledge, only one study considered both effects jointly by controlling also for outdoor activities
79 with the conclusion that axial length and sugary diet were not associated [27]. However, in this study,
80 sugars and starches consumption were considered separately and without distinction of their refined
81 origin, possibly reducing the ability to detect an effect. Moreover, this study found a statistically
82 significant link between consumption of saturated fatty acids as well as cholesterol level and increase
83 in axial length. Saturated fat is a known antagonist of insulin and a contributor to insulin resistance[28],
84 so these findings lend some support to the hyperinsulinemic theory of Cordain et al [16]. Thus, the
85 contribution of these two hypotheses, near-work or diet, to the emergence of juvenile onset myopia is
86 unclear.

87 The aim of this study was to simultaneously test modifiable risk factors suspected to be
88 involved in the development of myopia in children, taking into account nutritional factors especially
89 the consumption of refined carbohydrates.

90

91 **Methods**

92 **Design**

93 All children age 4 to 18 years who attended the University Hospital Center of Montpellier from May
94 2017 to May 2018 were considered. We excluded children with organic ophthalmological pathologies
95 such as cataract, glaucoma, retinoblastoma, and Coat's disease but included those with a history of
96 amblyopia and functional strabismus.

97
98 **Measurements**

99 All included children underwent a complete ophthalmologic examination, including refraction under
100 cycloplegia, slit-lamp examination and dilated fundus examination. Children with refraction error ≥ 3
101 D in at least one eye were excluded because those individuals were considered as moderate to high
102 hyperopic and thus could not be used as control (i.e. non myopic). The resulting children were
103 considered myopic (< 0 D for one or both eyes; using a cut-off of $- 0.5$ D does not change qualitatively
104 the results) or controls (non-myopia for both eyes). Parents completed the study questionnaire to collect
105 the following information on the child: sex (M, F), age (year), height (cm), weight (kg), whether the
106 mother or father was myopic (yes/no), reading time (hours per day), screen time (tablets/cell phones,
107 video games, computers etc.; hours per day), outdoor time (hours per day), physical activities (yes/no)
108 and refined carbohydrates consumption by using a food frequency questionnaire (see Additional file 1
109 and 2) .

110 **Refined carbohydrates consumption.** Refined carbohydrates intake was measured by summing the
111 frequency of weekly consumption of high glycaemic load products reported in the food frequency
112 questionnaire. Reported frequencies were transformed in weekly frequencies as follows: 0 for never,

113 0.5 for less than once a week, 1 for once a week, 2.5 for two to three times a week, 5 for four to six
114 times a week, 7 for every day. This food frequency questionnaire was adapted from the one used in the
115 French national cohort Constances, designed to reflect intake in the French population, selected food
116 items being compliant with the nutritional guidelines from the French National Nutrition and Health
117 Program (PNNS) [29].

118

119 **Cycloplegic refraction.** Cycloplegia was obtained with administration of cyclopentolate (Skiacol,
120 Alcon, Fort Worth, TX, USA) or IsoptoAtropine (Alcon, Fort Worth, TX, USA) at 0.5% for children
121 age 4 to 12 years and 1% for children age 12 to 18 years as recommended by French health authorities.
122 Instillation protocols were those validated in current practice: 1 hr, 55 and 50 min before measurement
123 for Skiacol and twice a day for 5 days before measurement for IsoptoAtropine. Refraction was
124 measured by using a NIDEK TONOREF II Auto Refractometer (Nidek medical, Settimo Milanese,
125 Italy) in children age 12 to 18 years and the Retinomax 2 Portable Self-Refractometer (Visionix,
126 Bensenville, IL, USA) when the child's cooperation did not allow use of the TONOREF II.

127

128 **Statistical analyses**

129 All statistical analyses involved using R v3.5.2 (www.r-project.org) with MASS v.7.3-51.1 [30].
130 Logistic regression was used to analyse the probability of being myopic, estimating odds ratios (ORs)
131 and 95% confidence intervals (CIs). The binary response variable corresponded to spherical refractive
132 error < 0 D versus ≥ 0 D for at least one eye. Explanatory variables were reading time per day
133 (quantitative), screen time per day (quantitative), time spent outside per day (quantitative) and refined
134 carbohydrates consumption per week (quantitative). Control variables were z-scores for body mass
135 index (BMI [$\text{weight}/\text{height}^2$], based on the growth reference for age 5 to 19 years from the World

136 Health Organization <https://www.who.int/growthref>; quantitative), mother and father myopia
137 (categorical), sex (categorical), age (quantitative) and sport (categorical). All quantitative variables
138 were centered. The following interactions were analysed beforehand: age with sex, screen time, reading
139 time, outside time, and sport; sex with screen time, reading time, outside time, and sport; and refined
140 carbohydrates consumption with sport, sex, outside time, and age. The significance of each term was
141 assessed from the model including all the other variables by using a likelihood ratio chi-square test.
142 $P < 0.10$ was considered statistically significant for interactions. The variance inflation factor was
143 calculated by the function `vif` in the R package `car` [31].

144

145 **Results**

146 **Population description**

147 Among 264 children with age 4 to 18 years, 86 (32.6%) were myopic in at least one eye, with an
148 unequal distribution by sex (girls: 49/128 [38.3%], boys: 38/136 [27.9%]). We included 180 children
149 exhibiting refraction < 3 D in both eyes in the study: 88 (48.9%) girls and 92 (51.1%) boys. The mean
150 age of children was 9.5 years old. The description of their characteristics is in Table 1 and the age
151 distribution is in Table 2. The description of vision status is in Table 3. Two categories of vision status
152 were considered: myopic in one or both eyes ($N = 86$; 49 girls, 37 boys; Table 3) and non-myopic in
153 both eyes ($N = 94$; 39 girls, 55 boys).

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159 **Table 1.** Characteristics of children included in the study (n=180).

	Girls (N = 88)						Boys (N = 92)					
	Myopic ^a (N=49)			Non-myopic ^b (N=39)			Myopic ^a (N=37)			Non-myopic ^b (N=55)		
	Mean	SD	Range	Mean	SD	Range	Mean	SD	Range	Mean	SD	Range
Age (years)	10.43	4.06	4–17	8.31	3.32	4–17	10.89	3.72	4–17	8.31	3.65	4–18
BMI ^c Z-score	0.21	1.47	-3.60–3.57	0.22	0.92	-1.27–2.03	-0.02	1.50	-5.03–2.45	-0.03	1.31	-3.38–2.45
Sphere right eye (D)	-2.62	2.57	-8.50–1.50	0.94	0.89	0.00–2.75	-3.37	2.78	-12.00–0.00	1.01	0.92	0.00–2.75
Sphere left eye (D)	-2.62	2.91	-10.25–2.25	0.88	0.86	0.00–2.5	-3.21	2.77	-9.75–0.00	1.00	0.99	0.00–2.75
Outdoor time (hr/day)	2.48	1.40	0.57–6.43	2.63	1.38	1.28–7.14	2.31	1.22	0.57–5.86	2.89	1.65	1.00–7.14
Reading (hr/day)	0.73	0.21	0.50–1.00	0.68	0.21	0.50–1.00	0.71	0.20	0.50–1.00	0.65	0.20	0.50–1.00
Screens (hr/day)	2.63	0.61	1.00–4.00	2.29	0.48	1.00–3.25	2.78	0.57	2.00–4.00	2.47	0.53	0.50–3.50
Refined carbohydrates consumption (frequency/week)	41.94	13.56	13.00–86.00	35.04	11.06	10.00–53.50	35.03	12.04	0.50–56.00	40.78	10.98	11.50–56.50

160 ^aMyopic on one or both eyes ($D < 0$)

161 ^bNon myopic on both eyes ($0 \leq D < 3$)

162 ^cBMI, body mass index

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Table 2. Distribution of the children by age class.

Age, years	Girls (N=88)	Boys (N=92)	All (N=180)
4–6	26 (29%)	31 (34%)	57 (32%)
7–10	28 (32%)	28 (30%)	56 (31%)
11–18	34 (39%)	33 (36%)	67 (37%)
All	88 (100%)	92 (100%)	180 (100%)

171 **Table 3.** Vision status of children.

Vision status for both eyes	Girls (N = 88)	Boys (N = 92)	All (N = 180)
Myopic ^a both eyes	41 (46%)	35 (38%)	76 (42%)
Myopic and emmetropic ^b	3 (3%)	2 (2%)	5 (3%)
Myopic and hypermetropic ^c	6 (7%)	0 (0%)	5 (3%)
Emmetropic and hypermetropic	1 (1%)	2 (2%)	3 (2%)
Emmetropic both eyes	13 (15%)	18 (20%)	31 (17%)
Hypermetropic both eyes	25 (28%)	35 (38%)	60 (33%)
All (myopic one or both eyes)	49 (56%)	37 (40%)	86 (48%)
All (non-myopic in both eyes)	39 (44%)	55 (60%)	94 (52%)
All	88	92	180

172 ^arefraction error < 0D173 ^brefraction error = 0D174 ^c0D < refraction error < 3D

175

176 **Effects on probability of myopia**

177 Only the interactions age with screen time, age with reading time and sex with refined carbohydrates
178 consumption were significant ($\chi^2=3.74$ df=1 $P=0.053$, $\chi^2 =5.50$ df=1 $P=0.019$ and $\chi^2 =12.7$ df=1
179 $P=0.0003$, respectively) and were thus kept in the final model. The final model (Table 4, Fig. 1)
180 explained 22% of the total deviance and the variance inflation factor was < 2.5, indicating weak
181 multicollinearity between covariables, and did not need to be accounted for [31]. The effect of refined
182 carbohydrates consumption on myopia differed by sex ($\beta= -0.133$; $P<0.001$; OR=0.87; 95% CI, 0.81–
183 0.94, Table 4, Fig. 1). The consumption of refined carbohydrates significantly increased the probability
184 of myopia for girls ($\beta= 0.068$; $P=0.009$; OR=1.07; 95% CI, 1.02-1.13) and decreased it for boys ($\beta= -$
185 0.065; OR=0.94; 95% CI, 0.89–0.98; $P=0.011$). Myopia was associated but not significantly with
186 screen time ($\beta= 0.844$; OR= 2.32; 95% CI, 0.89-6.05; $P=0.083$), and outdoor time seemed protective
187 but was not significant ($\beta= -0.307$; OR= 0.74; 95% CI, 0.54-1.01; $P=0.057$). The age with reading time

188 interaction was marginally significant ($\beta = -0.555$; OR= 0.57; 95% CI, 0.33-1.00; $P=0.050$), which
 189 indicates less myopia with increased age and reading time. Male sex was inversely associated with
 190 myopia ($\beta = -1.047$; OR= 0.35; 95% CI, 0.15-0.8; $P=0.015$) all things being equal. Parental myopia had
 191 no significant influence, either when myopia of each parent were considered separately (for both,
 192 $P>0.50$), or when the number of myopic parent (0, 1 or 2) was considered as a quantitative variable
 193 ($P=0.973$).

194 **Table 4.** Association of risk variables on the probability of myopia in children. For categorical data, the
 195 estimates are for one category compared to the reference category (underlined term). For each variable,
 196 the estimate β , standard error of the mean (SE), Z value and corresponding P -value, Odd-ratio with
 197 95% confidence interval are given. Bold characters indicates significant ($P < 0.05$) effects. Italic
 198 characters indicates trends ($P < 0.1$).

	β	SE	z value	$P(> z)$	OR (95% CI)
Intercept	-0.253	0.548	0.055	0.956	
Refined carbohydrates consumption (frequency/week)	0.068	0.026	2.615	0.009	1.071 (1.017–1.127)
Screen time (hr/day)	0.844	0.488	1.731	<i>0.083</i>	2.326 (0.894–6.049)
Reading time (hr/day)	0.281	1.065	0.264	0.792	1.325 (0.164–10.694)
Outdoor time (hr/day)	-0.307	0.161	-1.903	<i>0.057</i>	0.736 (0.536–1.009)
Mother myopia (yes/ <u>no</u>)	0.231	0.438	0.528	0.598	1.260 (0.534–2.975)
Father myopia (yes/ <u>no</u>)	-0.282	0.467	-0.604	0.546	0.754 (0.301–1.885)
Sport (yes/ <u>no</u>)	0.421	0.501	0.839	0.401	1.523 (0.570–4.073)
Age (years)	0.103	0.067	1.548	0.122	1.109 (0.973–1.263)
Sex (boys/ <u>girls</u>)	-1.047	0.430	-2.438	0.015	0.351 (0.151–0.814)
BMI z-scores	-0.103	0.160	-0.645	0.519	0.902 (0.658–1.235)
Interactions					
Age with screen time	0.183	0.129	1.424	0.154	1.201 (0.933–1.547)
Age with reading time	-0.555	0.283	-1.959	<i>0.050</i>	0.574 (0.330–1.000)
Sex with refined carbohydrates consumption (boys with refined carbohydrates consumption / <u>girls with refined carbohydrates consumption</u>)	-0.133	0.037	-3.565	3 10⁻⁴	0.875 (0.814–0.942)

199

200 **Discussion**

201 This study aimed at evaluating conjoint modifiable risk factors involved in the development of
202 myopia in a French paediatric population, including the impact of consumption of refined
203 carbohydrates. We found an association between child myopia and this type of diet. Risk of myopia
204 was increased for girls with refined carbohydrate consumption but decreased for boys. Some already
205 known risk/protective factors of myopia were concurrently detected: screen time was marginally
206 associated with increased probability of myopia and outdoor time seemed protective.

207 **Carbohydrates consumption and myopia.** Since the seminal study of Cordain (2002), very few
208 studies had focused on the possible effect of refined carbohydrate consumption on myopia [17, 27].
209 Here we found a positive association between refined carbohydrates consumption and prevalence of
210 myopia in girls aged 4 to 18 years but a negative one in boys. Refined carbohydrates (refined starches
211 and sugars) are rapidly absorbed into the bloodstream, inducing a high peak of insulin
212 (hyperinsulinemia), The more a carbohydrate is refined, the larger is the glycaemic and insulinaemic
213 responses which can be measured by the glycemic load [32]. Fructose is an exception, being
214 metabolised independently of insulin action in the liver. However, chronic hyperinsulinemia and
215 fructose metabolism leads to insulin resistance [16, 33–35] and compensatory hyperinsulinemia[36–
216 38], associated with many health challenging condition [39, 40]. Cordain et al. (2002) and recently
217 Galvis et al. (2016) suggested that this hyperinsulinism could increase the elongation of the globe via
218 the promotion of increased insulin-like growth factor-1 (IGF-1) and decreased insulin-like growth
219 factor binding protein-3 (IGFBP-3) action in scleral fibroblasts [16, 17].

220 The increase in prevalence of myopia observed in all countries or populations that have adopted
221 a sugar-rich western diet supports this hypothesis [3, 41, 42], even if several social and/or genetics

222 factors are modulating this correlation. For example, Alaskan Inuit moved from a 0-2% prevalence of
223 myopia to > 50% prevalence in a single generation as a result of a westernised lifestyle including eating
224 habits [41]. Morgan and Munro (1973) reported similar patterns in several ethnic groups of the Yukon
225 and Northwest regions of Canada, where myopia prevalence rates were also age-dependent [42]. Wong
226 et al. (1993) found an increase in myopia prevalence (18.4%) among urban Hong Kong fishermen who
227 had not attended school, which suggests that lifestyle factors such as changes in eating habits could be
228 involved in the prevalence of myopia [43].

229 Unexpectedly, we showed a negative association between refined carbohydrate consumption
230 and myopia for boys. The result that carbohydrates play different roles in boys and girls was
231 unexpected, and not previously reported. This result cannot be attributed to quantitative difference in
232 consumption between the sexes, as the sex had no significant influence on refined carbohydrate
233 consumption recorded ($P = 0.63$, details not shown), although the qualitative difference of high refined
234 carbohydrates consumption was not considered here. This finding could be due to the frequency of
235 carbohydrates consumption not really capturing boy's chronic hyperglycemia because boys are more
236 physically active than girls at all ages [44].

237 **Outdoor time and myopia.** Time spent outside seemed a protective factor in myopia, in agreement
238 with several studies [12, 13, 45], although the association was here marginally significant. It has been
239 shown in children that the elongation of the globe, and the subsequent increase in myopia, was greater
240 in winter than summer [46]. This effect could result from the increase exposure to natural light during
241 lengthening days in summer, or less near-work and more outdoor activities in summer [46]. However,
242 possible variations in seasonal diet were not controlled for. This protective trend of exposure to natural
243 light is based on the assumption that such exposure increases the release of dopamine in the retina, a
244 neurotransmitter known to reduce eye growth in experimental studies [47, 48]. Although these findings

245 are from animal models, they are consistent with the results of study in humans.

246 **Near-work and myopia.** On-screen and reading activities requiring near vision are described as a risk
247 factor for myopia [49]. Here, we detected a marginal effect of screen time, although the contribution of
248 reading time did not seem a significant risk factor. The absence of an effect of reading time could be
249 due to the relatively young age of the children (32% were < 7 years old; Table 2) with high probability
250 of illiteracy. The association between near-work and myopia could also be due to people with myopia
251 engaging in more near-work because taking part in some sports might be difficult when wearing
252 spectacles. A prospective study reported that myopic children may be more at risk of lower levels of
253 physical activity than their non-myopic peers [50]. However, we did not find a significant effect of
254 sport practice on myopia.

255 **Prevalence of myopia.** Variations in the prevalence of myopia by geographical location are well
256 documented [6, 49, 51]. However, the prevalence of myopia in French children has been less studied
257 than in other countries, with limited current data available to understand its evolution in the context of
258 the worldwide increase in myopia incidence. Overall, the proportion of myopic patients in our initial
259 sample reached 32% (38% for girls, 28% for boys). The lower prevalence of myopia in boys is
260 consistent with data from other countries [13, 52]. However, the representativeness of our sample
261 relative to the global paediatric population in France is probably biased because data were collected
262 from hospital consultations, and recruitment included many strabismus patients who were potentially
263 hyperopic in the context of accommodative strabismus.

264 **Limitations.** The size and diversity of the population studied is one of the main limitations. Patients
265 were recruited during medical consultations, which implies some selection bias. Moreover, although
266 the composition of dietary intake varies between age 4 and 18 years, only one food frequency
267 questionnaire was used. In addition, the subjective measurement of refined carbohydrates intake

268 through questionnaire is another limitation. A larger cohort and a food frequency questionnaire that is
269 more age-appropriate will be required to confirm and refine our results.

270

271 **Conclusion**

272 This study supports the findings of recent research on risk factors for myopia development and brings
273 new results for the potential effect of refined carbohydrates consumption on this visual disorder.

274 Further prospective studies are needed to confirm these findings and to disentangle the mechanisms by
275 which diet can affect myopia. This study also reinforces the belief that modifiable risk factors for
276 myopia could be targets for future public health actions in France and around the world.

277

278

279 **Abbreviations**

280 Not applicable

281

282 **Declarations**

283 **Ethics approval and consent to participate.** The study was reviewed and approved by the ethics
284 committee of Montpellier Hospital Center and complied with the tenets of the Declaration of Helsinki.

285 Written informed consent was obtained from the parents of all included children and data were
286 analysed anonymously.

287 **Consent for publication.** Not applicable.

288 **Availability of data and materials.** The datasets used and/or analysed during the current study are
289 available from the corresponding author on request.

290 **Competing interests.** The authors declare that they have no competing interests.

291 **Funding.** No funding was required for the completion of this study.

292 **Authors' contributions.** Study design : CB, MR and VD. Data acquisition: SM and AC. Analysis and
293 interpretation of data: CB and MR. Write the manuscript: CB and SM. Revise the manuscript: CB, MR,
294 MV and VD. All authors have read and approved the content and agree to submit for publication in the
295 journal.

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298

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410

411 **Figure**

412 Fig. 1. Adjusted odd ratios and 95% confidence intervals for the model studying the impact of risk and
413 control variables on the probability of myopia in children. For categorical data, the estimates are for
414 one category compared to the reference category (underlined term). * P < 0.05 ** P < 0.01 **** P <
415 0.001

416

417 **Additional files**

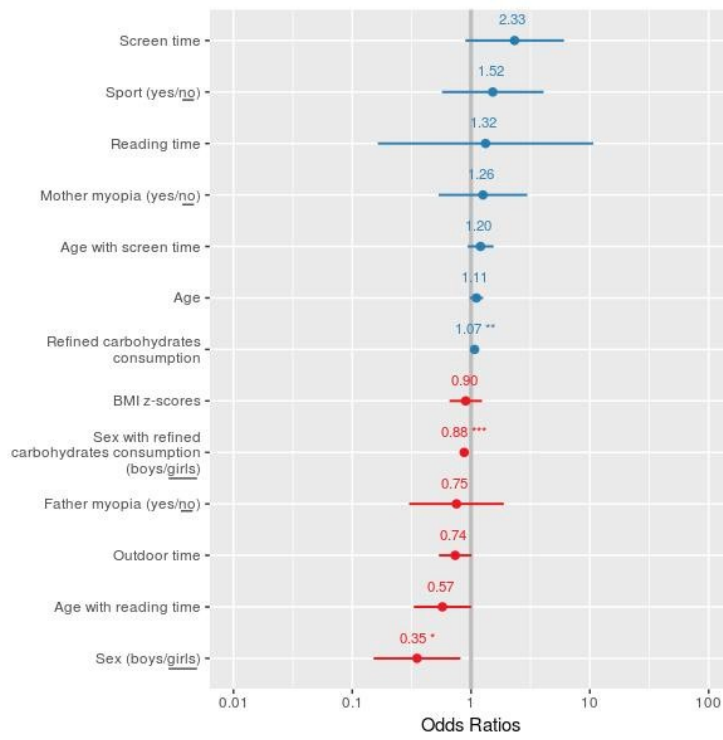
418 Additional file 1.doc

419 Title: Food frequency questionnaire.

420

421 Additional file 2.doc

422 Title: Original version of food frequency questionnaire.



423 Fig. 1

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430 Additional file 1

431 How often does your child consume the following foods or beverages, regardless of how they are stored (fresh, canned or
 432 frozen), when they are eaten (meals or between meals) and where they are consumed (home or out of home) ?
 433

Foods:	Never or almost never	Less than once a week	1 time per week	2-3 times per week	4-6 times per week	Every day
Meat, poultry, egg, fish						
Milk						
Unsweetened dairy products (cheese, fresh cheese, yogurt, white cheese,...)						
Sweetened dairy products (cheese, fresh cheese, yogurt, white cheese,...) (already sweet or in which your child adds sugar, honey, jam, compote...)						
Sweet desserts (dessert cream, mousse, ice cream, compote, fruit in syrup), ...						
White bread, rusks, crackers, sandwich bread,...						
Wholemeal bread, buckwheat bread, rye bread, wholemeal rusks,						
Breakfast cereals						
Muesli without added sugar						
White starchy foods (pasta, rice, potato, semolina, flour, ...)						
Wholemeal starchy foods (wholegrain pasta, rice, semolina, flour, ...)						
Legumes (lentils, dry beans, chickpeas,...)						
Vegetables (raw or cooked)						
Fruits (excluding pressed fruit juices)						
Ready to eat food						

Fast food products (hamburgers, pizzas, quiches,...)						
Fried food (french fries, chips, donuts,...)						
Aperitif snacks						
Cookies						
Nuts (peanuts, walnuts, hazelnuts, almonds,...)						
Cakes, pastries, viennoiseries						
Chocolate or cereal bars						
Sweets						
Jam, cocoa, honey, sugar						
Sugar sweetened beverages (cola, ice-tea,...)						
Fruit juices (pressed or not, with or without added sugar)						

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447 Additional file 2

448 Habituellement, à quelle fréquence votre enfant consomme-t-il les aliments ou boissons suivants, quel que soit leur mode de
 449 conservation (frais, en conserve ou surgelé), le moment de consommation (repas ou hors repas) et le lieu (domicile ou hors
 450 domicile) ?

Aliments :	Jamais ou presque	Moins d'1 fois par semaine	1 fois par semaine	2 à 3 fois par semaine	4 à 6 fois par semaine	Tous les jours
Viande, volaille, œufs, poissons, charcuterie						
Lait						
Produits laitiers (fromage, petits suisse, yaourt, fromage blanc,...) non sucrés						
Produits laitiers (fromage, petits suisse, yaourt, fromage blanc,...) sucrés (déjà sucrés ou dans lesquels votre enfant rajoute sucre, miel, confiture, compote...)						
Desserts sucrés (crème dessert, mousse, glace, entremet, compote avec sucre ajouté, fruits au sirop), ...						
Pain blanc, biscottes, pain de mie blanc, tartines craquantes, pains suédois						
Pain complet, intégral, au sarrasin, au seigle, biscottes complètes						
Céréales pour le petit-déjeuner						
Muesli sans sucre ajouté						
Féculents blancs (pâtes, riz, pomme de terre, semoule, farine, ...)						
Féculents de type complet (pâtes complètes, riz complet, semoule complète, farine complète,...)						
Légumes secs (lentilles, haricots secs, pois-chiche,...)						
Légumes crus ou cuits						

Fruits frais (hors fruits pressés)						
Plats cuisinés du commerce (en conserve, surgelés, traiteur,...)						
Plats de restauration rapide (hamburgers, pizzas, quiches,...) du commerce (surgelés ou frais).						
Aliments frits de type frites, chips, beignets,...						
Biscuits salés						
Biscuits sucrés						
Graines (cacahuètes, noix, noisettes, amandes,...)						
Biscuits, gâteaux, pâtisseries, viennoiseries						
Barres chocolatées, de céréales						
Bonbons						
Confiture, cacao, miel, sucre en poudre ou en morceaux						
Sodas, boissons aromatisées sucrées (ice-tea, oasis,...)						
Jus de fruits						

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