

1 **Prevalence and Risk Factors for Child Labour and Violence against Child in Egypt**
2 **using Bayesian Geospatial Modelling with Multiple Imputation.**

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12 **Abstract**

13 **Background:** The incidence of child labour, especially across the developing nations is of
14 global concern. The use of children in employment in developing economies constitutes a
15 major threat to the societies, and concerted efforts are made by the relevant stakeholders
16 towards addressing some of the factors/issues responsible for the menace. Significant risk
17 factors include socio-demographic and economic factors, including poverty, neglect, lack of
18 adequate care, and exposure of children to various grades of violence, parental education
19 status, gender, place of residence, household size, residence's type or size, wealth index,
20 parental survivorship and household size. **Objectives:** This study, therefore, focuses on
21 identifying socio-demographic/economic and geospatial factors associated with child labour
22 participation. **Methods:** We utilised 2014 Demographic and Health Survey (EDHS) from the
23 Ministry health and Population in Egypt, with the record of **20, 560** never married children
24 aged 5-17years engaging in economic activities, in and out of their home. The data focused
25 on demographic and socio-economic characteristics of household members. Multivariate
26 Bayesian geo-additive models were employed to examine the demographical and socio-
27 economic factors for children working less than 16hrs; between 16 and 45hrs and above
28 45hours weekly. **Results:** The results showed that at least 31.6% of the children in the age
29 group from 5-10 were working, 68.5% of children aged 11-17 years engaging in child labour
30 (wage), while 44.7 of the children in the age group from 5-10 were engaged in hazard work.
31 From the multivariate Bayesian geo-additive models, the female children (with male children
32 as reference category) working at least 16hrs (OR: 1.3; with 95% CI: 1.2-1.5) are more likely

33 to be engaged in child labour than those working 16 to 45hours (OR: 1; 95% CI: 0.3-1.5).
34 Children born to women without formal education, under non-hazardous jobs, irrespective of
35 the hours spent at work, were mostly exposed to child labour with following percentages:
36 52.9%, 56.8%, 62.4%, compared to children of mothers with some levels of education.
37 Finally, children that have experienced psychological aggression and physical punishment are
38 mostly exposed to child labour than those without such experience across the job types and
39 hours spent. **Conclusion:** This study revealed a significant influence of socio-demographic
40 and economic factors on the children labour and violence against children in Egypt. Poverty
41 neglects, lack of adequate care and exposures of children to various grades of violence are
42 major drivers of child labour across the country. North-eastern region of Egypt has a higher
43 likelihood of child labour than most other regions, while children who live in Delta are more
44 engaged in hazard work.

45 **Keywords:** Child labour, violence against Child, Risk factors, Geospatial effects.

46 **Introduction**

47 The General Assembly of the United Nations issued in 1989 (Resolution 44/25) a convention
48 for the rights of the children that defines a child as every human being below eighteen years
49 of age. This convention emphasized the need to seek to protect the child from performing any
50 work that could be hazardous, interfere with education, or damage his or her health or
51 physical, mental, spiritual, moral or social development [1]. It also necessitated the Member
52 States to take legislative, administrative, social and educational measures to ensure such
53 protection. In addition, these states are obligated, according to this convention, to set a
54 minimum age for employment, determine an adequate system of working hours and working
55 conditions and impose appropriate penalties to ensure the effective application of these
56 conditions.

57 The International Labour Organisation (2004) reported in 2004 that in 1999–2000 overall
58 poverty in Egypt stood at 20.2%; with the poverty incidence appears to be highest in urban
59 Upper Egypt (36.33%), followed by rural Upper Egypt (34.68%), but it is lowest in the
60 Metropolitan region (9.01%). At least 12 million people could not fulfil their basic food and
61 non-food needs [2].

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64 Recent statistics indicate that there are around 11 million children (under 15) in Egypt and of
65 these 11 million, around, 1.6 million work as child labour (ages 6 to 15) [3]. In 2014, the
66 World Food Program and the European Union reported that the number of employed minors
67 in Egypt jumped to at least 2.7 million. Most of them work six days a week, an average of 12
68 hours a day or more. They constitute an additional source of income for their families, who
69 depend on the income to provide for one-third of their expenditures. Approximately 78% are
70 employed in the countryside, and most of them are females. Between 1 and 1.5 million are
71 employed in agricultural labour. Of all working children, 84% live in rural areas while 16% in
72 urban areas. Some recent statistics indicated that children who were engaged in child labour
73 have experienced punishment and abuse, largely physical or verbal.[3-4]

74 Egypt has agreed to the ratification of the present Treaty in addition to many international
75 treaties, which eliminate the criminalized economic exploitation of children, including the
76 international labour treaty No. 138 of 1973, which aimed (long-term) for the total elimination
77 of child labour. Also, Egypt has agreed with the international labour treaty No. 182 of 1999,
78 which came complimentary to the Treaty No. 138, which urges the elimination of the worst
79 forms of child labour initially, with the goal of eliminating child labour. All forms of child
80 labours are included by this agreement which also emphasizes the importance of free basic
81 child education [3]. Despite this, the distribution of the population by age indicates that a
82 relatively high percentage of the population is young: those below the age of 15 years
83 represent about 37.5 % of the total population. Out of this 37.5 %, 7 % of Egyptian children
84 were engaged in child labour in 2009 [2]. Egypt is the fourth highest country in child labour
85 according to the World Bank, 2015 [4]

86 The major contributing factors to child labour in Egypt are poverty, declining economic
87 conditions, and rising inflation which means that the situation is likely to worsen [3]. The
88 poverty index measures severe health deprivation by the proportion of people who are not
89 expected to survive to age 40. Based on this metric, the 2004 Human Development Report
90 (HDR) submitted that 3.1% (2.2 million people) of the total population of Egypt lives on less
91 than USD 1 per day [3]. Figure 1 shows the risk factors influencing household concerning
92 child labour as reported [5]

93 The Central Agency for Public Mobilization and Statistics (CAPMAS) reported that there are
94 12 million Egyptians who are homeless, of whom 1.5 million are living in cemeteries [6].

95 It has been reported also in the same source that the number of people living below the
96 poverty line in Egypt increased to 26.3 % of the population in 2013 compared to 25.2% in
97 2011 [6]. The report showed that the urban frontier governorates had the lowest poverty rate
98 with 11.4 %, while rural Upper Egypt governorates showed the highest poverty rate with
99 49.4 %. Also, it was found that among the illiterate, 37 % are poor while only 8 % of those
100 who finished universities were poor. The poor clearly exists in large households with more
101 than 10 members where 67 % of these households are poor [6].

102 The problem is that it is difficult to find accurate statistics on child workers or accurate
103 studies that have discussed this problem properly. Therefore, there is an urgent need for a
104 study that can describe this problem accurately and discuss the causes of it and provide some
105 suggestions that may help decision makers to handle this issue. In particular, the recent
106 political changes in Egypt may offer a chance to encourage the new government to deal with
107 this problem. Due to the negative effect of this phenomenon on the society, it is important to
108 precisely investigate this problem further and thoroughly using the results to shape the policy
109 and dedicated to improved outcomes for children [7].

110 **Materials and Methods**

111 The analysis in this work is based on the data obtained from the 2014 Egypt Demographic
112 and Health Survey (EDHS) ([S1 Data](#)) which is the most recent data on child labour in Egypt.
113 The 2014 EDHS data conducted by Egypt's Ministry of Health and Population, the National
114 Population Council in collaboration with Macro International. (See Ministry of Health and
115 Population, El-Zanaty and Associates, and ICF International for detail information about
116 methods used in EDHS [8] [9]). As this was a secondary data analysis of open access data,
117 ethical approval was not required. The sample for the 2014 EDHS was designed to provide
118 estimates of population and health indicators, welfare indicators, and other indicators rates for
119 the country as a whole and for six major subdivisions (Urban Governorates, urban Lower
120 Egypt, rural Lower Egypt, urban Upper Egypt, rural Upper Egypt, and the Frontier
121 Governorates).[8]

122 The sample likewise allows for estimates of most key indicators at the governorate level.

123 In order to allow for separate estimates for the major geographic subdivisions and the
124 governorates, the number of households selected from each of the major sectors and each
125 governorate was disproportionate to the size of the population in the units.[8]

126 Thus, the dataset was weighted before proceeding with the analysis.

127 **Study area and data**

128 The 2014 EDHS on child labour allows for an assessment of several key aspects of the
129 welfare of Egypt's children. Questions were included on birth registration and living
130 arrangements and the survival status of parents. Data also were collected on the prevalence of
131 injuries and accidents and disabilities among young children. A child's access to education is
132 critical, and the EDHS obtained information on both the level of pre-school education among
133 young children and children's participation in primary and secondary school.

134 The survey also looked at the extent of child labour and at the practices used in disciplining
135 children. In the 2014 EDHS, the first step in the administration of the Child Labour and Child
136 discipline modules involved the identification of a single child age 1-17 years for whom the
137 questions in the modules would be asked depending on the child's age. If the household
138 included more than one child in the age range, the child for whom the modules were
139 administered was selected using a Kish grid¹. If the selected child was 1-14 years, the Child
140 Discipline module was administered for the child. To account for the selection of one child
141 per household, the child discipline data are weighted. The weight is based on the de jure
142 population of children age 1-17 years [8].

143 **Description of outcome variables**

144 The 2014 EDHS considered the never-married children aged 5-17 years who are involved in
145 economic activities inside or outside the home according to the child's age and a number of
146 hours worked. However, The MICS program has defined thresholds based on the child's age
147 and the number of hours a child worked during the week to classify children's involvement in
148 economic activities (MICS2014). This study, however, has used the ILO classifications
149 which are classified based on the number of hours worked per week into three groups as
150 follows: A) Less= 16rs a week; B) between 16 and less than 45hrs a week; and C) over 45hrs
151 a week.

152 The economic activities were classified into three groups, such as:

153 A) Non-Hazardous wage work. B) Hazardous wage work. C) Household work.

¹ The Kish grid gives a procedure of selection. The expression "Kish grid" comes from the name of Leslie Kish, the Hungarian born American statistician. Kish was one of the world's leading experts on survey sampling.

154 Risk factors and covariates

155 We considered the following socio-demographic factors and the associated risk factors of the
156 child labour as explanatory variables: child's age (5-17years), sex, household size, place of
157 residence, wealth index, mother education, father education, parental survivorship and violent
158 discipline approaches against children. The wealth index was used as proxies for the socio-
159 economic position of the household because EDHS does not collect information on
160 household income and expenditure. Egypt comprises 27 governorates, which were
161 categorised by EDHS into 7 areas namely: Urban governorates, Lower Egypt urban, Lower
162 Egypt rural, Upper Egypt urban, Upper Egypt rural and Frontier governorates. However, in
163 spatial analysis, we have used 27 governorates to investigate the spatial effects in the
164 prevalence of overlap economic activities of children at the state level. This was achieved
165 using a geo-additive semi-parametric multinomial model [9]. Figure 2 shows the multilevel
166 risk factors of child labour that applied to this study.

167 Statistical Methods

168 Let Y_{ijk} and π_{ijk} represent the type of work and probability of working hours respectively.
169 Let working hours of at least 15hr be $(k = 1)$; working hours falling between 16 and
170 45hrs a week be $(k = 2)$, and the working hours of over 45hrs a week be $(k = 3)$.

$$171 \quad Y_{ij} \sim MN(P_{ij}, N_{ij})$$

172 We assume that Y_{ijk} is distributed as a multinomial distribution, such that: $Y_{ij} \sim MN(1, \pi_{ijk})$
173 where $\pi_{ijk} = (\pi_{ij1}, \pi_{ij2}, \pi_{ij3})'$. Given some categorical covariates, Z_{ij} , metrical covariates, u_{ik}
174 and state-specific random effect, S_{ik} , the probability can be modelled thus:

$$175 \quad P_{ijk} = \frac{\eta_{ijk}}{S_k \eta_{ijk}} = \frac{\exp(\eta_{ijk})}{\sum_1^k \exp(\eta_{ijk})}; \forall k = 1, 2, 3$$

176 The predictor, η_{ijk} is given by $\eta_{ijk} = z_{ij}\beta_k + f_k(u_{ij}) + S_{ik}$ where η_{ijk} is a known response
177 function with a logit link function, β_k is the vector of the regression parameters (explanatory
178 variables such as gender, place of residence, etc.) and f_k is a smooth function for the metrical
179 covariates (child's age) which were assumed to be nonlinear in some previous studies for
180 each of the status categories k [10] [11] [12] [13]. We have included these variables as

181 nonlinear metrical covariates in the early stage of this study; however, the pattern did not
182 show exactly the significance level of each category. Therefore, we used these covariates as
183 linear effects instead to assess the significance level of each category. We set the first
184 category as reference and used the logit link for the modelling.

185 The random effects, S_{ik} are district or sub-district specific factors, which can be split into
186 spatially structured variation (θ_{ik}) and unstructured multinomial heterogeneity (ϕ_{ik}), such
187 that, $S_{ik} = \theta_{ik} + \phi_{ik}$. P-spline priors were assigned to the functions; f_1, f_2, \dots, f_p whereas, a
188 Markov random field prior was used for $f(s_j)$ [14] [15].

189 To estimate model parameters, we applied the fully integrated Bayesian approach. Though
190 the estimation method with this model is difficult, the estimated posterior odds ratios (OR)
191 that were produced could be understood as similar to those of normal logistic models. The
192 analysis was carried out using version 2.1 of the BayesX software package, which certifies
193 Bayesian inference, based on Markov chain Monte Carlo (MCMC) simulation techniques
194 [16] [17] [18].

195 Both the descriptive statistics and chi-square tests were carried out to examine the level of
196 associations between predictors, confounders, and outcome variables using version 14 of
197 STATA; with the p-values of less than 0.05 considered statistically significant. The
198 multinomial logistic regression model was used to determine the degree of associations
199 between the outcome variables (a type of work indicators) and all the predictors. Posterior
200 Odds Ratios (OR) and their 95% confidence intervals (CI's) were estimated.

201 **Multiple imputations Analyses (Missing data)**

202 This dataset has a significant proportion of missing data (**S5 Table**) although the missingness
203 is concentrated only in a few variables. At this stage, we will assess the monotone patterns
204 and the joint probability of missing across variables; thereafter which we will identify the
205 potential predictors of each variable that requires modelling ([19], [20], [21], [22]).

206 One analytic option is to use only that dataset with complete observations, or we can replace
207 the missing values, through a process termed 'imputation'. The simplest imputation replaces
208 the missing value with mean or median value for that variable; though, this is not a desirable
209 process, especially when one is examining the relationships between variables.

210 However, the more sophisticated method, termed ‘multiple imputations’, predicts missing
211 values for a variable using existing values from other variables. The predicted values, called
212 “imputes”, are substituted for the missing values, resulting in a full data set called an
213 “imputed data set” [23], [19]. This method imputes dataset using standard procedures for
214 complete data and combining the results from these analyses.

215 No matter which complete-data analysis is used, the process of combining results from
216 different data sets is essentially the same. In other words, we use the data from units where
217 both (Y, X) are observed to learn about the relationship between Y and X . Then, use this
218 relationship to complete the data set by drawing the missing observations from, $X|Y$. This
219 process is completed at if least $N=5$ times, giving rise to N complete data sets. Then each of
220 these imputed data sets is analysed and we combine the results using specific rules. It does
221 not attempt to estimate each missing value through simulated values but rather to represent a
222 random sample of the missing values [20], [23]. Multiple imputations inference involves
223 three distinct phases as follows:

- 224 1) Create imputed data sets which are plausible representations of the data.
- 225 2) Perform the chosen statistical analysis on each of these imputed data sets by using standard
226 procedures.
- 227 3) The results from the complete data sets are combined "average" for the inference to
228 produce one set of results.

229 Analyses based on Multiple imputed data will avoid bias only if enough variables that predict
230 the missing values are included in the imputation models. Therefore, including as many
231 predictors as possible tends to make the missing-at-random assumption more plausible [20].
232 However, including more than 25 predictors will increase the variance explained in the
233 prediction equations [24]

234 Multiple imputations are a more appropriate choice as a solution to missing data problems as
235 it represents a good balance between quality of results and ease of use. It has been shown to
236 perform favourably compare to other methods in a variety of missing data situations [25],
237 [26]. It can also produce unbiased parameter estimates which reflect the uncertainty
238 associated with estimating missing data. Furthermore, it has been shown to be robust to
239 departures from normality assumptions and provides adequate results in the presence of low
240 sample size or high rate of missing data.

241 The results of some previous studies using the most commonly used multiple imputation
242 methods, are Expectation Maximization (EM-algorithm) [14], [15] and the Monte Carlo
243 Markov chain (MCMC) [16] [27] method showed there was no significant difference
244 between EM algorithm and MCMC method for item imputation; and that the number of items
245 used for imputation has little impact, either [17].

246 However, in this study, we have applied MCMC method based on pseudo-random draws and
247 this will allow us to obtain several imputed data. It is known that MCMC can be used with
248 both arbitrary and monotone patterns of missing data. It is known as a collection of
249 techniques for simulating random draws from difficult probability distributions via Markov
250 chains. MCMC also is especially useful in Bayesian statistical analyses and for solving
251 difficult missing-data problems [14].

252 **Assumptions about Missing Data**

253 If EDHS data contain observations that were missing completely at random, the observations
254 would constitute a random sample of the complete dataset. Multiple imputations assume that
255 the observed variables are predictive of the missing values and that the data are missing at
256 random. Missing data are said to be missing at random (MAR) if the probability that data are
257 missing does not depend on unobserved data but may depend on observed data. MCAR can
258 be viewed as a particular case of MAR.

259 On the other hand, if the subjects are withdrawn from the study for ethical reasons, missing
260 would not be MAR. This type of missing-data mechanism is called missing not at random
261 (MNAR). For such missing data, the reasons for its missingness must be accounted for in the
262 model to obtain valid results. We looked at missing data patterns and also assessed the extent
263 of missing in the variables that were included in the analysis. Nonlinear relationships were
264 treated using semiparametric models (e.g. generalised additive models (GAMs) [28]. It was
265 important to include the outcome variable (in this case, economic activates) as a predictor in
266 the imputation model because failing to do so will dilute the associations between the
267 outcome and the other variables [18] [19].

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272 **Results**

273 **Prevalence and Sectoral Distribution of Child Labour:**

274 **S1 Table** shows statistics on children work and education in Egypt according to the
275 UNESCO Institute for Statistics, 2015. While **S2 Table** shows an overview of children's
276 work by sector and activity in Egypt according to the US Department of labour report, 2016
277 [30][31]

278 **S1 Table** shows that at least 6.7% of the children in the age group from 5-14 are working,
279 88.1% of children aged 6-14 years combine schooling with engaging in child labour. Only
280 10.8% completed the primary school. **S2 Table** provides an overview of children's work by
281 sector and activity in Egypt. It shows that over 52% of children are working in Agriculture
282 followed by 30.4% who are engaged in service sectors [30][31]

283 **Distribution of Factors Analysed in Child Labour in Egypt (DHS 2014)**

284 **S3 Table** presents the distribution of socio-demographic factors relating to child labour
285 including violence against children, aged 5-17 years in Egypt with respect to the weekly
286 length of working hours in jobs that are hazardous, non-hazardous and household-based.

287 The following factors were significantly associated with Non-hazardous wage work (see **S3**
288 Table): gender of a child (P=0.002); residence type, household size, place of residence and
289 wealth indices (P=0.001 each); violent discipline approach, especially: psychological
290 aggression (P=0.002) and physical punishment (P=0.08). However, the following factors:
291 parental education, parental survivor and severe punishment were not significant in this
292 category. For the hazardous wage work, the non-significant factors were household size,
293 Parental Survivorship, and Psychological aggression against children. Gender, the age of
294 children under 2, place of residence, wealth indicators, mothers' education, physical and
295 severe punishments (each with P=0.001). Father' education has a slight effect. For household
296 work, all the factors were highly significant (each with P=0.001).

297 Further, the percentage of male children exposed to child labour is largely higher than those
298 of female children, irrespective of the job type (Non-hazardous, hazardous and household-
299 based work) and the length of jobs, except for female children in a household job, and are
300 working at least 16 hours weekly have the higher percentage of 69.1% and 61.5%

301 respectively than the male children. Also, children from rural communities are more exposed
302 to child labour than their colleagues from urban cities with higher percentages across the
303 board of job type and hours spent at work.

304 Children living in the medium household and into non-hazardous jobs are apparently having
305 highest exposure rates (53.6%, 50.5% and 50.7%) compared to their mates in both small and
306 large households, irrespective of the hours spent at work. Children from Lower and Upper
307 Egypt were engaged in non-hazardous and household jobs and they have the highest
308 percentage across the three periods of a job than others from another region. However, for the
309 hazardous jobs, children from the Lower Egypt area seem to have the highest percentage of
310 exposure to child labour.

311 For the wealth indicators, children from the poorest homes were more exposed into non-
312 hazardous jobs with the following percentages (68.4, 53.8 and 44.4) for the three hours of at
313 least 16 hours, 16-45hrs and "above 45hrs" respectively than their colleagues at the remaining
314 wealth indices. The same with the poorest children working at least 45hrs in both hazardous
315 and household jobs have a higher percentage of exposure to child labour than their colleagues
316 from the remaining homes.

317 Children born to women without formal education, under non-hazardous jobs, irrespective of
318 the hours spent at work, are mostly exposed to child labour with following percentages:
319 52.7%, 56.8% 62.4%, compared to children of mothers with some levels of education. Also,
320 children whose both parents are alive seem to be most exposed to child labour under
321 household job condition than their mates without living parents.

322 Finally, children that have experienced psychological aggression and physical punishment are
323 mostly exposed to child labour than those without such experience across the job types and
324 hours spent. The same with those who have experienced severe physical punishment compare
325 to their counterparts who have not experienced severe physical punishment.

326 **Associate Risk Factors with Child Welfare including Child Labour and Violence against** 327 **Child issues in Egypt**

328 **S4 Table**, however, displays the multinomial regression results on socio-demographic factors
329 relating to child's labour, among the children aged 5-17 years in Egypt with respect to the
330 weekly length of working hours in jobs that are hazardous, non-hazardous and household-
331 based. The table presents the estimated effects of the categorical variables: Sex of child,

332 Residence's type, Household size, Place of Residence, Wealth index, parental education,
333 Parental Survivorship and Violent discipline approaches.

334 Columns 1&2 present the odds of children working "less than 16 hours" weekly as against
335 those working "between 16 and 45 hours" weekly, under Non-hazardous working condition.
336 For example, the results show that female children (with male children as reference category)
337 working less than 16hrs (OR: 1.3; with 95% CI: 1.2-1.5) are more likely to be impacted by
338 child labour than those working 16 to 45hours (OR: 1; 95% CI: 0.3-1.5). Also, for those
339 under household job, female children working between 16 and 45hours (with OR: 1.7; 95%
340 CI: 0.9-3.2) are more likely to be involved in child labour than those working at less than
341 16hrs weekly (OR: 1.2; 95% CI: 0.7-2). Finally, under the hazardous working condition,
342 female children working 16-45hrs (OR: 1.6 and 95% CI of 1.4-2.7) are more at risk than
343 those working "less than 16hrs" weekly (OR: 0.6; 95% CI: 0.3-1.5)

344 Similarly, Children aged 11-15 (OR: 0.5 and 95% CI: 0.4-0.8) are more likely to be at risk
345 than those aged over 15 years (OR: 0.4; 95% CI: 0.3-0.6) under the non-hazardous working
346 condition for "less than 16hrs" and for 16-45hrs of the weekly job. Although, the OR does not
347 seem significant in both age groups. Also, for children under household job, 11-15 of age
348 children are more likely to be at risk of child labour (OR: 2.3 and 95% CI: 0.9-5.6) compared
349 to those who are over 15 and are in 16-45hrs weekly job category. However, for the
350 hazardous job, children aged over 15 years who are working "less than 16hrs" (OR: 1.36;
351 95% CI: 0.3-3.2) are more at risk of child labour compared to their counterparts who are
352 under age of 15.

353 Rural children under 16-45hrs of the weekly job are more likely to be at risk than those
354 children working less than 16hrs a week under non-hazardous job. However, urban children
355 under non-hazardous and hazardous job more likely to be at risk compared to rural children,
356 regardless of the number of hours. However, rural children under household jobs are more
357 likely to be affected by child labour compared to urban children.

358 Children living under medium household who are working 16-45hrs weekly (with OR: 1.4;
359 95% CI: 1.3-1.6) have increased the risk of child labour in the non-hazardous job than those
360 of hazardous and household jobs. However, for those children in the large household, and
361 working less than 16hrs a week under hazardous condition (OR: 1.6; 95% CI: 0.5-2) may
362 likely to have a higher risk, compared to others at the two other working environments.

363 The poorer children working under the hazardous condition for "less than 16hrs" weekly
364 (OR: 1.93; 95%CI: 0.29-12.8) are likely to be most at risk compared to their colleagues
365 subjected to the two other working conditions. The same experience goes to the middle-class
366 children (OR: 2.3; 95%CI: 0.4-10.07). However, for the children from the richer and the
367 richest families, those under household job and are working "less than 16hrs" weekly, or 16-
368 45hrs are more likely to be at risk of child labour than other children who are in the other two
369 working conditions.

370 The half-orphans whose fathers are dead tending to be more exposed to the risks of child
371 labour, under non-hazardous and household-based job than those whose mothers are deceased,
372 irrespective of the hours of labour. However, for the children exposed to hazardous jobs,
373 those with deceased mothers are more likely to be at risk than those with deceased father.

374 Further, children who are exposed to psychological aggression and are working 16-45hrs
375 weekly (OR: 3.7; 95%CI: 1.5-9.5), under non-hazardous job, are more likely to be at risk of
376 child labour than their counterparts subjected to the two other working conditions. The same
377 with children subjected to severe physical punishment. However, the risk likelihood is
378 highest for children in household jobs, who are subjected to physical punishments, especially,
379 those working less than 16hrs weekly (OR: 9.3; 95%CI: 4.2-20.8).

380 **Figure 3** shows the structured spatial effects of child labour. The results confirmed evidence
381 of regional differences in the likelihood of a child exposed to different type of works. From
382 the graph, it is clear the North-eastern region of Egypt has a higher likelihood of child labour
383 than most other regions. Using Frontier governorate as a reference, children residing in Upper
384 Egypt Rural have the highest risk of having all of three child labours. Hazard work is likely to
385 be in Delta (Suez) Canal, Ismailia, other neighbour cities); whilst, the lower and upper Egypt
386 are more affected by household work. Similarly, the likelihood of being exposed to Non-
387 hazard work is higher in lower and upper Egypt.

388 **Discussion**

389 This study emphasises the significance of seeking child protection against engaging in any
390 job or task that could be hazardous, interfere with education, or damage his or her health or
391 physical, mental, spiritual, moral or social development in line with the UN convention. On
392 the note of which we find it imperative to investigate impacts of socio-demographic factors
393 and the associated risk factors on the child labour in Egypt. We reviewed how poverty,

394 declining economic conditions, and rising inflation continue to worsen the situation across
395 various parts in Egypt. To achieve the aim of this study, the UNESCO (2015)' statistics on
396 the distribution of children aged 5-14 years, of the school age who engages in child labour
397 across different sectors, are examined.

398 We then cross-classified the economic activities of the children aged 5-17, who are never-
399 married and are of the school age, based on the number of hours worked per week, subject to
400 ILO classifications against the socio-demographic and spatial factors to determine the level of
401 association between these factors and the nature of jobs these children are exposed to. We
402 went further to determine which of the socio-economic and spatial factors and the associated
403 risk factors are likely to expose these children to the risks inherent in the various labours they
404 are engaged.

405 From the results, we found that gender, age, household size, place of residence, regions,
406 violent discipline method, parental education and survivorships and wealth status of the
407 children are all predisposing factors of the children to the child labour at different working
408 conditions. Specifically, we found that the percentage of male children in non-hazardous
409 jobs; working longer hours are more than female children. However, more than 61% of
410 female children engaging in household jobs spend 16-45hours at work, compared to their
411 male counterparts with about 39% in household jobs. Likewise, female children spend more
412 hours weekly (over 45hrs) in household jobs compared to male children.

413 Percentage of children living in a medium household and working over 16hrs a week is
414 higher compared to those both in the small and large household. Children living in Upper
415 and Lower part of Egypt, those from the poorest home, those born by women without formal
416 education and those that have experienced both psychological and physical punishments have
417 higher percentage compared to their mates within the respective categories.

418 Further, we found that children aged 11-15 are more at risk of exposure to child labour than
419 those aged over 15 years. The same goes to the rural children, who have higher chances of
420 exposure than their colleagues from urban cities. Children from the poorer homes, those
421 whose fathers are dead and those subjected to psychological aggression and physical
422 punishment are more likely to be lured into child labour.

423 Apparently from on our findings so far, one could argue that there is evidence of child labour
424 in Egypt and that socio-demographic and spatial factors greatly predispose majority of the
425 children to it.

426

427 **Conclusion**

428 We have presented Bayesian geospatial modelling with multiple imputation models for child
429 labour and violence against child issues in Egypt. These types of epidemiological studies are
430 relatively rare. Most of the previous studies were limited to exploratory analysis of child
431 health only [29], [24] [25].

432 We have established evidence of the presence of child labour and the impacts of socio-
433 demographic and their associated risk factors on the child labour across Egypt

434 This study is novel because the association between geospatial factors, socio-demographic
435 factors, and child labour has not been investigated before in Egypt. The findings reveal a
436 significant influence of socio-demographic and economic factors on the child labour and
437 violence against children in Egypt. Significant of these findings is that poverty, neglects, lack
438 of adequate care and exposures of children to various grades of violence are major drivers of
439 child labour across the country. North-eastern region of Egypt has a higher likelihood of child
440 labour than most other regions, while children who live in Delta are more engaged in hazard
441 work. Government is therefore encouraged by the outcomes of this study to work towards
442 protecting the rights of children as enshrined in the United Nations convention and to educate
443 and empower children from the less-privileged families

444 **Strength and Limitations of this Study**

445 As much as we know, this is the first time study of this kind would be undertaken in Egypt on
446 geospatial factors impacting negatively on child labour. Also, it is the first study to our
447 knowledge which implements such advanced modelling whilst imputing the missing values
448 that usually affect the data of the child labour in developing countries. The study is done in
449 line with the 2014 EDHS, which promotes the assessment of several key aspects of the
450 welfare of Egypt's children. However, the level of missing observations in the data is a major
451 challenge in this study.

452

453 Author Contributions

454 Conceived and designed the experiments: KK. Performed the experiments: KK. Analysed the
455 data: KK. Contributed reagents/materials/analysis tools: KK. Wrote the Paper: KK MR.BS.
456 review: KK MR BS MI.

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523 **Figure Legends.**

524 Fig 1. Factors influencing household concerning child labour (Source: Understanding Child's
525 work, A joint LIO-UNICEF-The World Bank report, 2017).

526 Fig 2. A multilevel risk factors of child labour that applied in this study.

527 Fig3. Maps of Egypt showing the spatial effects (posterior OR) on Child labour: I. (A) less
528 than 16hrs a week Vs. (B) 16-45hours a week engagement in Household work, II. (A) less
529 than 16hrs a week vs. (B) 16-45hours a week engagement in wage work, III. (A) less than
530 16hrs a week Vs. (B)16-45hours a week engagement in Hazard work.

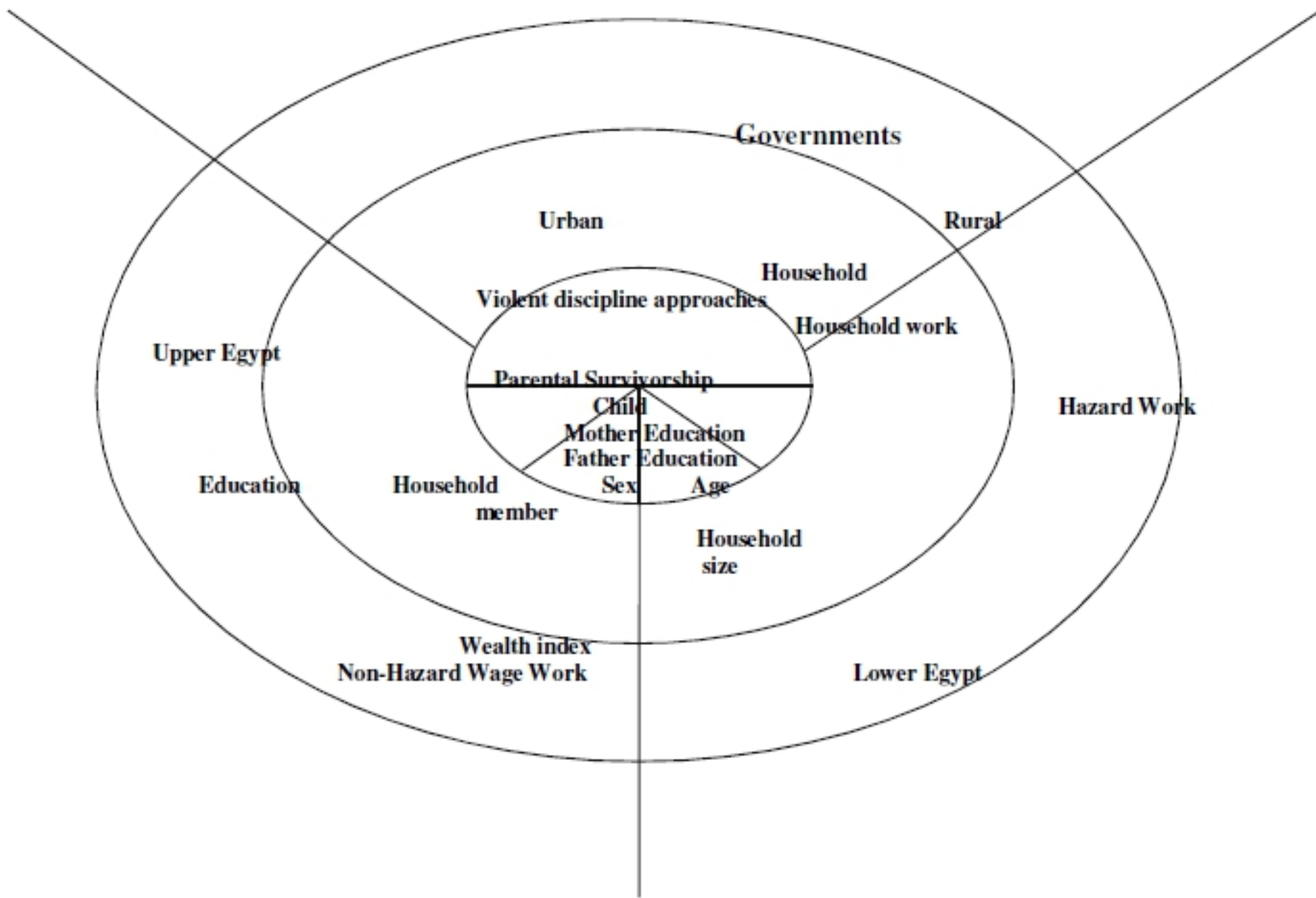
531 **Supporting Information.**

532 S1 Table. Statistics on children work and education in Egypt according to Data from 2013,
533 published by UNESCO Institute for Statistics, 2015

534 S2 Table. an overview of children’s work by sector and activity in Egypt according to the US
535 Department of labour report, 2016.

536 S3 Table. Distribution of factors analysed in child labour in Egypt (DHS 2014)

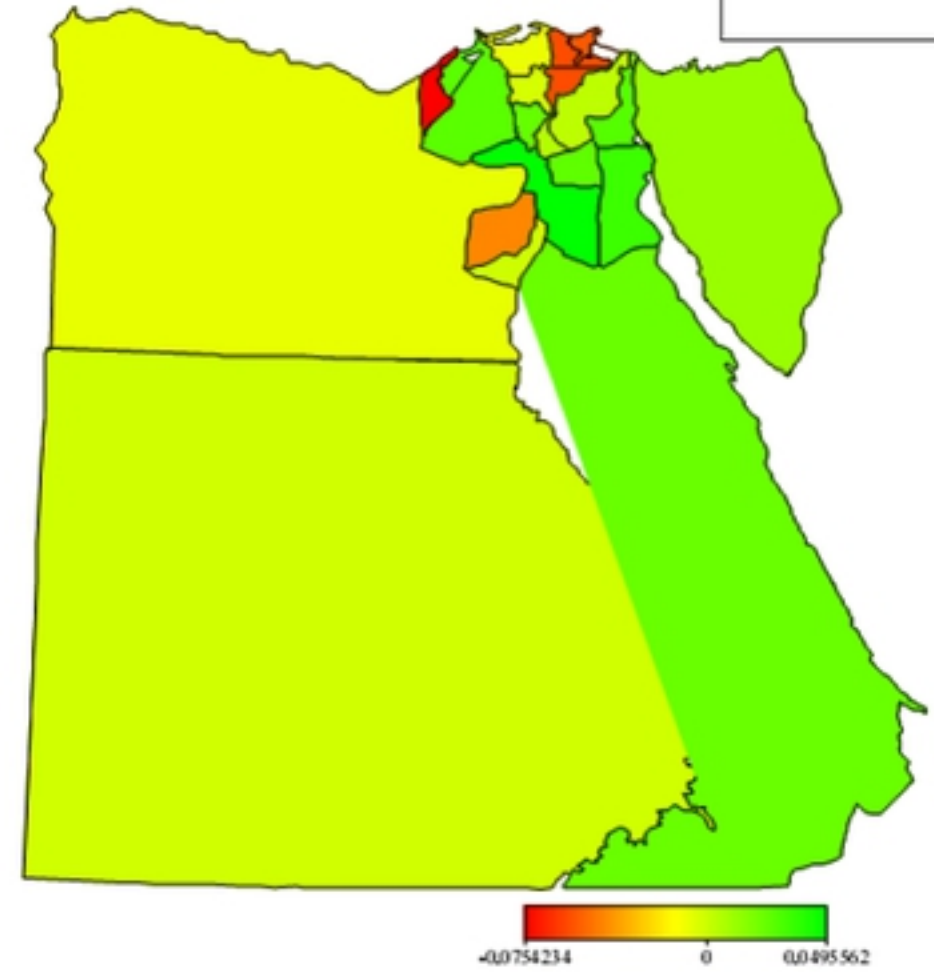
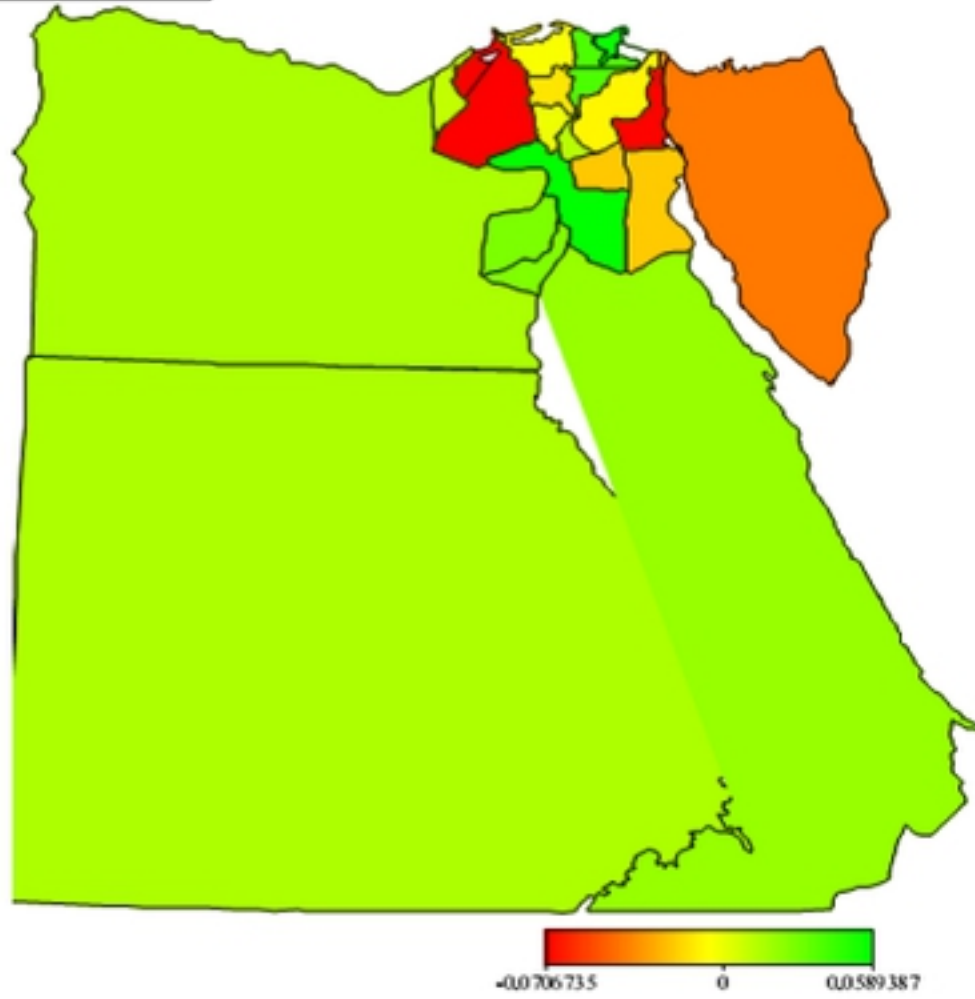
- 537 S4 Associate Risk Factors with Child Welfare including Child Labour and Violence against
- 538 Child issues in Egypt (DHS 2014).
- 539 S5 Missing values among the risk factors
- 540 S1 Data EDHS data 2014 on child labour



Figure

**A: less than
16hrs a week**

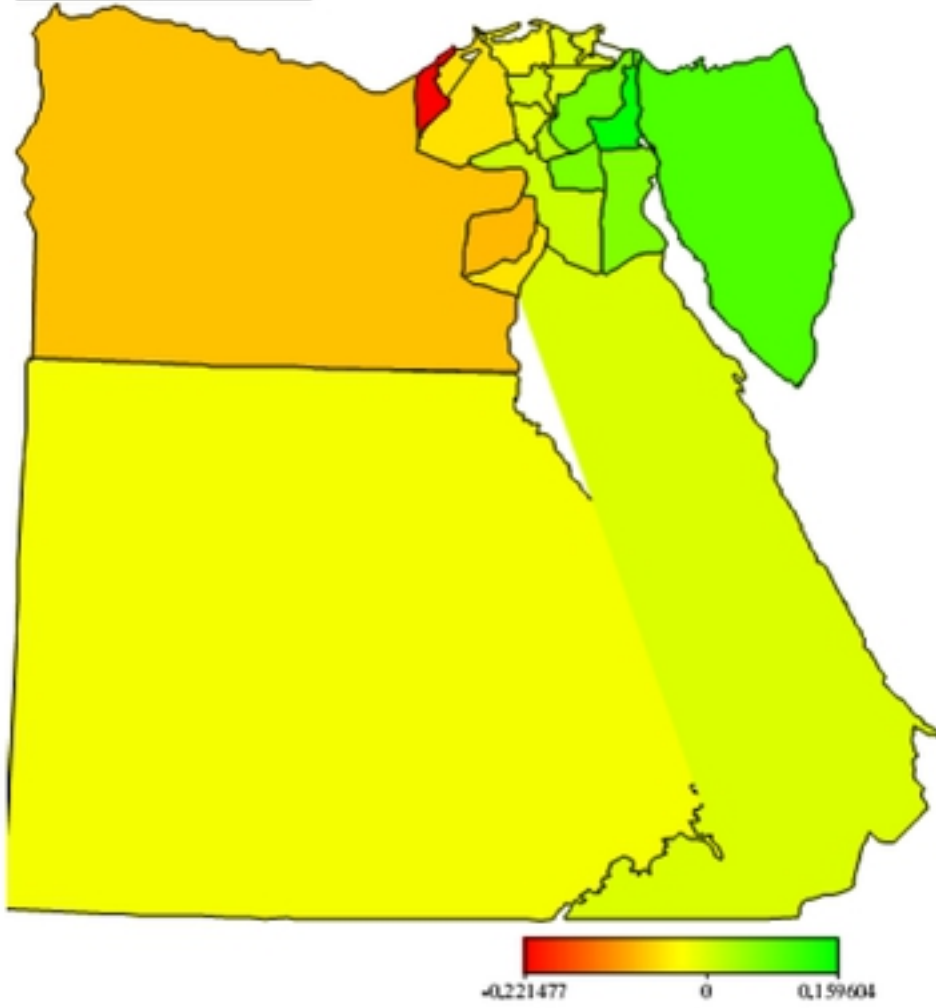
**B: 16-45hours a
week**



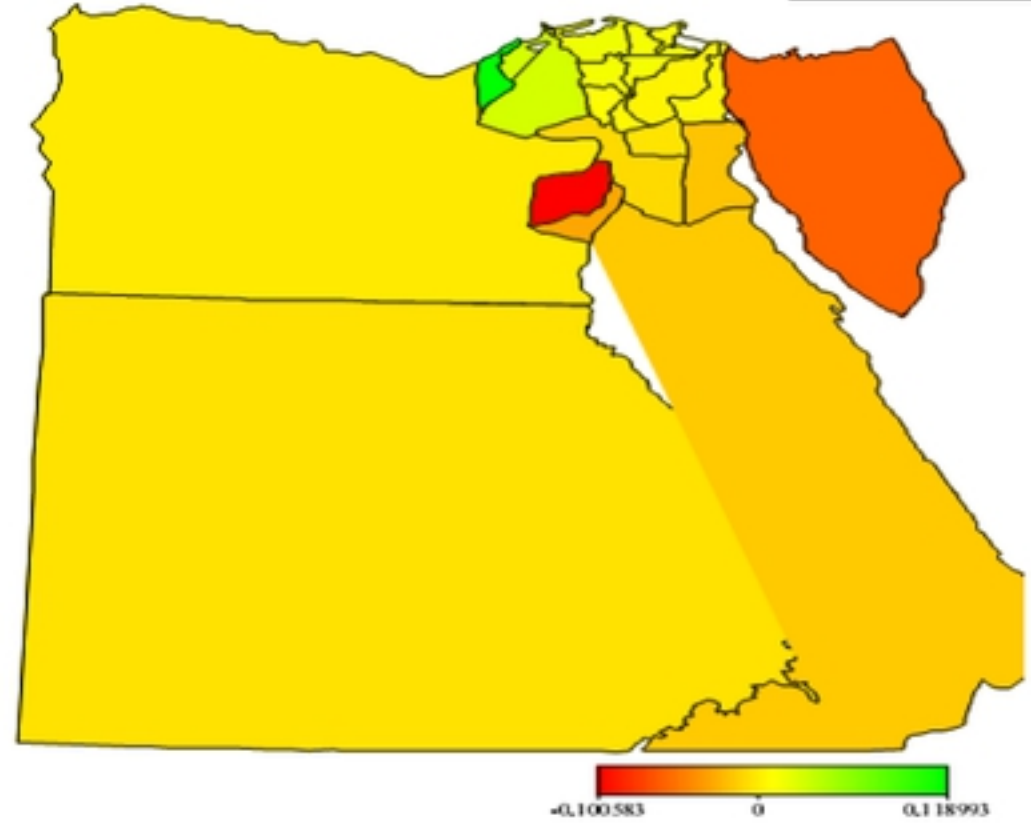
I.

Figure

A: less than
16hrs a week



B: 16-45hours a week

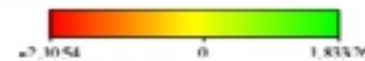
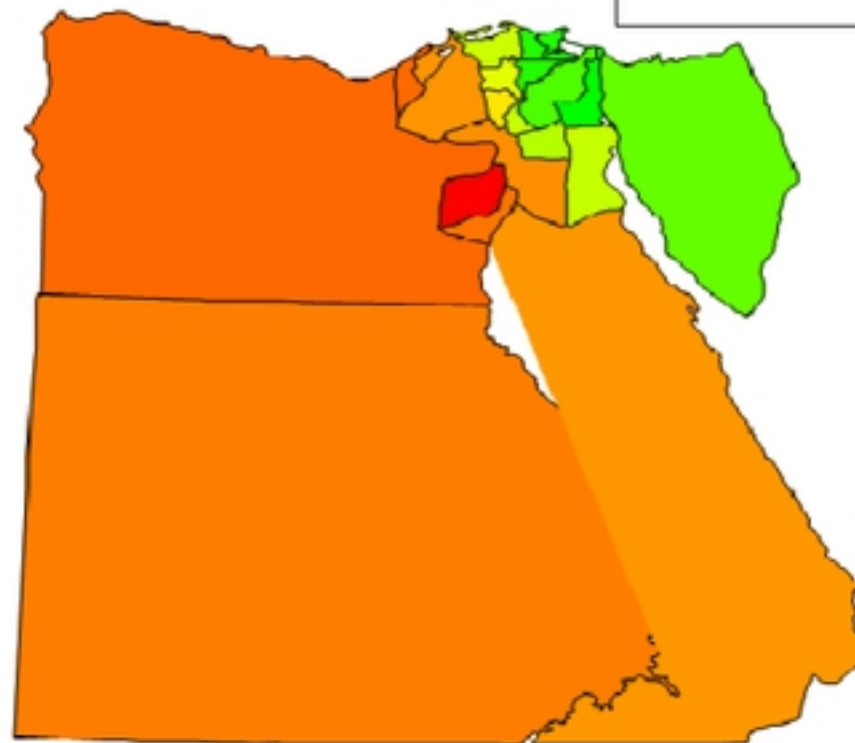
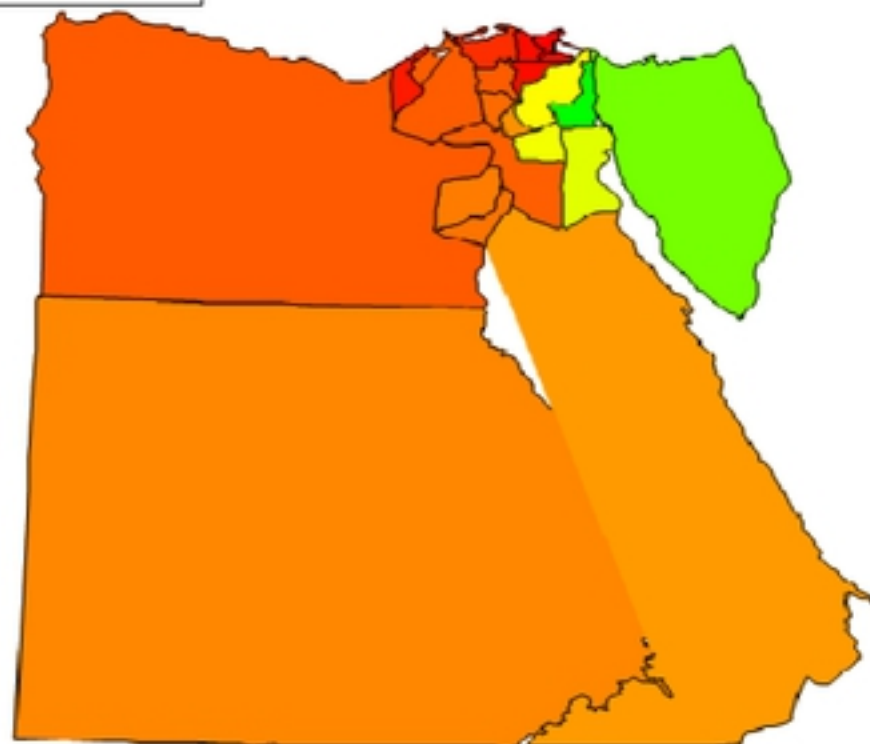


II.

Figure

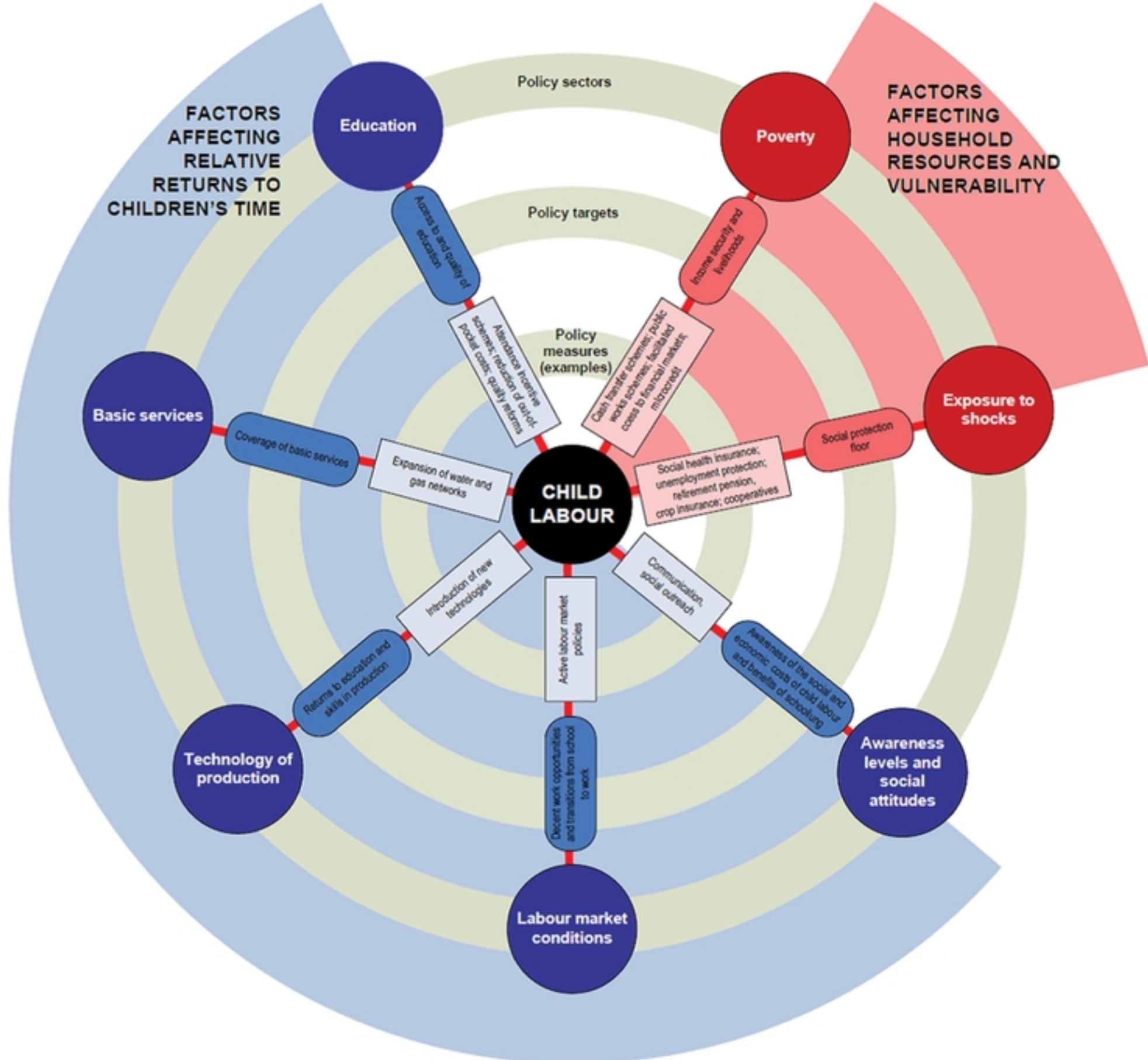
A: less than 16hrs a week

B: 16-45hours a week



III.

Figure



Figure