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 45hrours 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 while16% 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 grid[1]. 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.

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[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.

Risk factors and covariates

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

Statistical Methods

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

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

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

$$P_{ijk} = {}^{\eta_{ijk}}\!/_{S_k \eta_{ijk}} = \frac{\exp(\eta_{ijk})}{\sum_{1}^{k} \exp(\eta_{ijk})}; \forall k = 1,2,3$$

The predictor, η_{ijk} is given by $\eta_{ijk} = z_{ij}\beta_k + f_k(v_{ij}) + S_{ik}$ where η_{ijk} is a known response function with a logit link function, β_k is the vector of the regression parameters (explanatory variables such as gender, place of residence, etc.) and f_k is a smooth function for the metrical covariates (child's age) which were assumed to be nonlinear in some previous studies for 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; $f_1, f_2,...f_p$ whereas, a

188   Markov random field prior was used for $f(s_i)$[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].

Assumptions about Missing Data

252

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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Results

Prevalence and Sectoral Distribution of Child Labour:

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

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

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

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

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

Further, the percentage of male children exposed to child labour is largely higher than those of female children, irrespective of the job type (Non-hazardous, hazardous and household-based work) and the length of jobs, except for female children in a household job, and are 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 than16hrs 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

Conclusion

427

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

Author Contributions

Conceived and designed the experiments: KK. Performed the experiments: KK. Analysed the data: KK. Contributed reagents/materials/analysis tools: KK. Wrote the Paper: KK MR.BS. 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
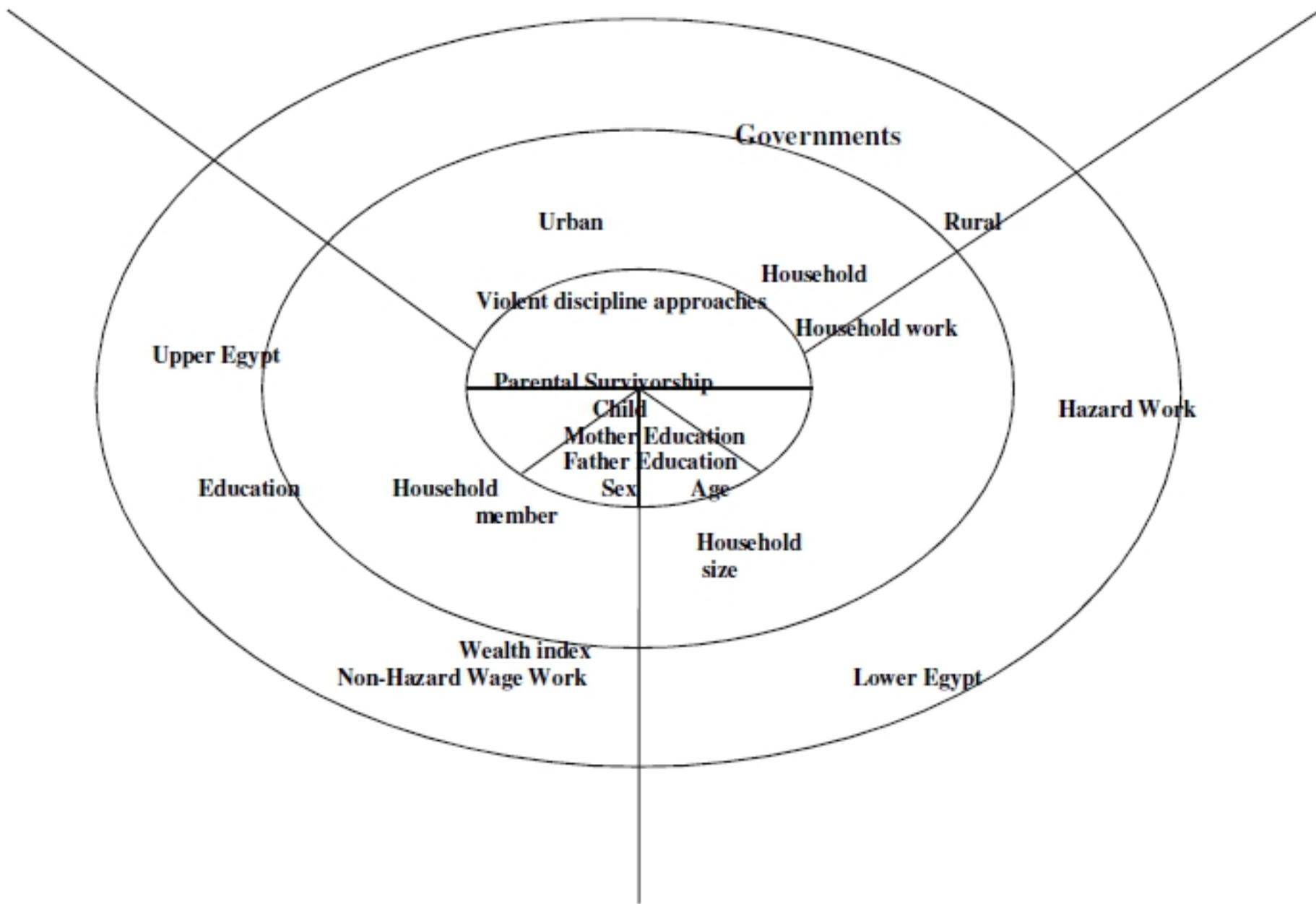530 16hrs a week Vs. (B)16-45hours a week engagement in Hazard work.

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.

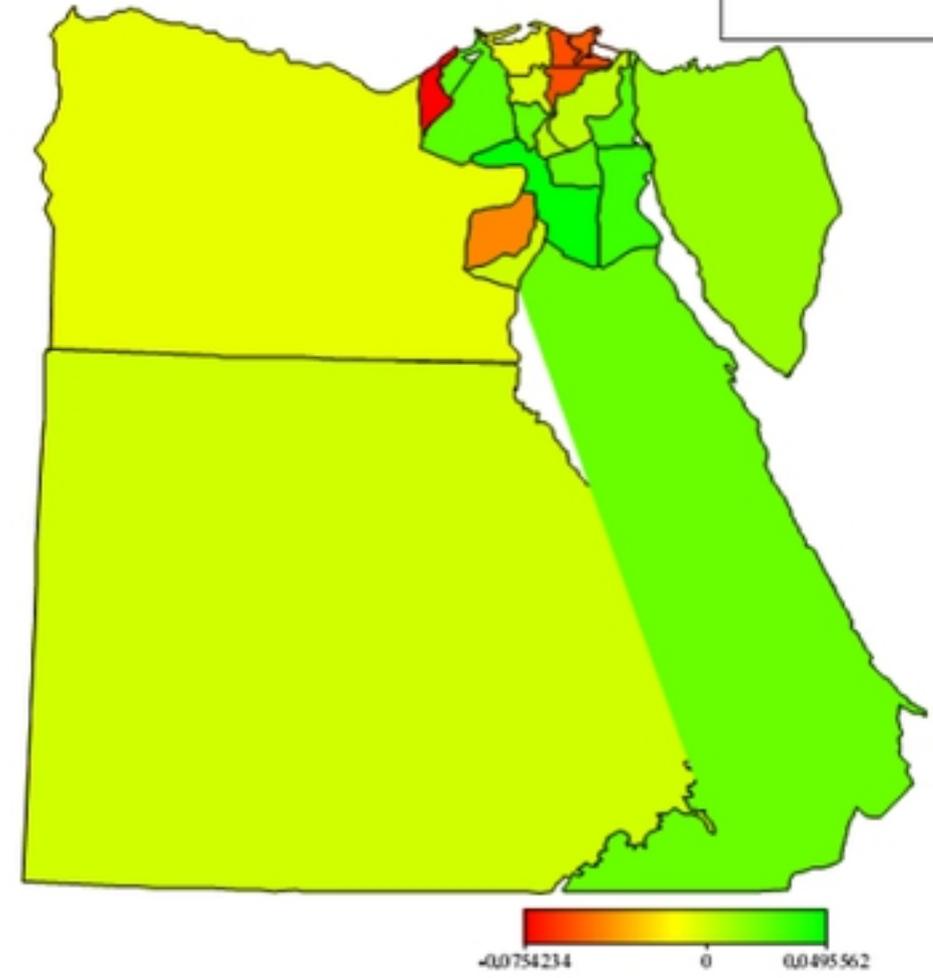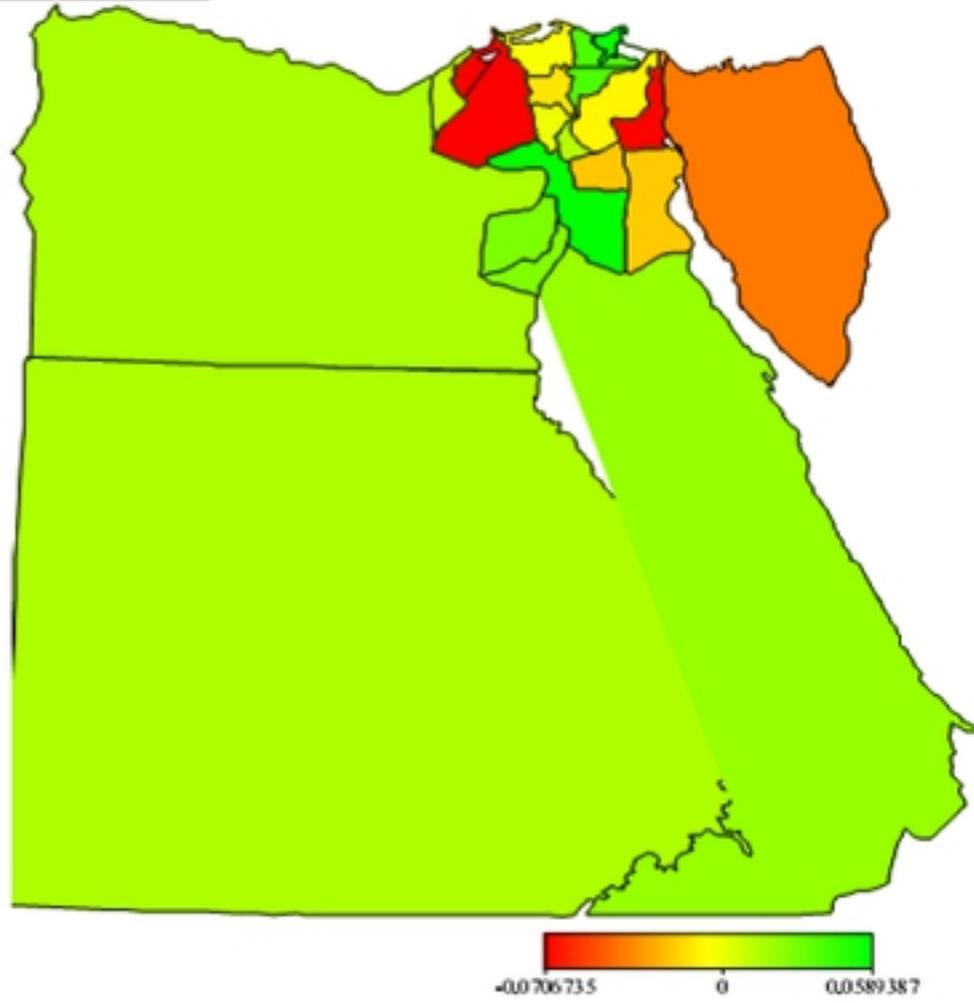536 S3 Table. Distribution of factors analysed in child labour in Egypt (DHS 2014)

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

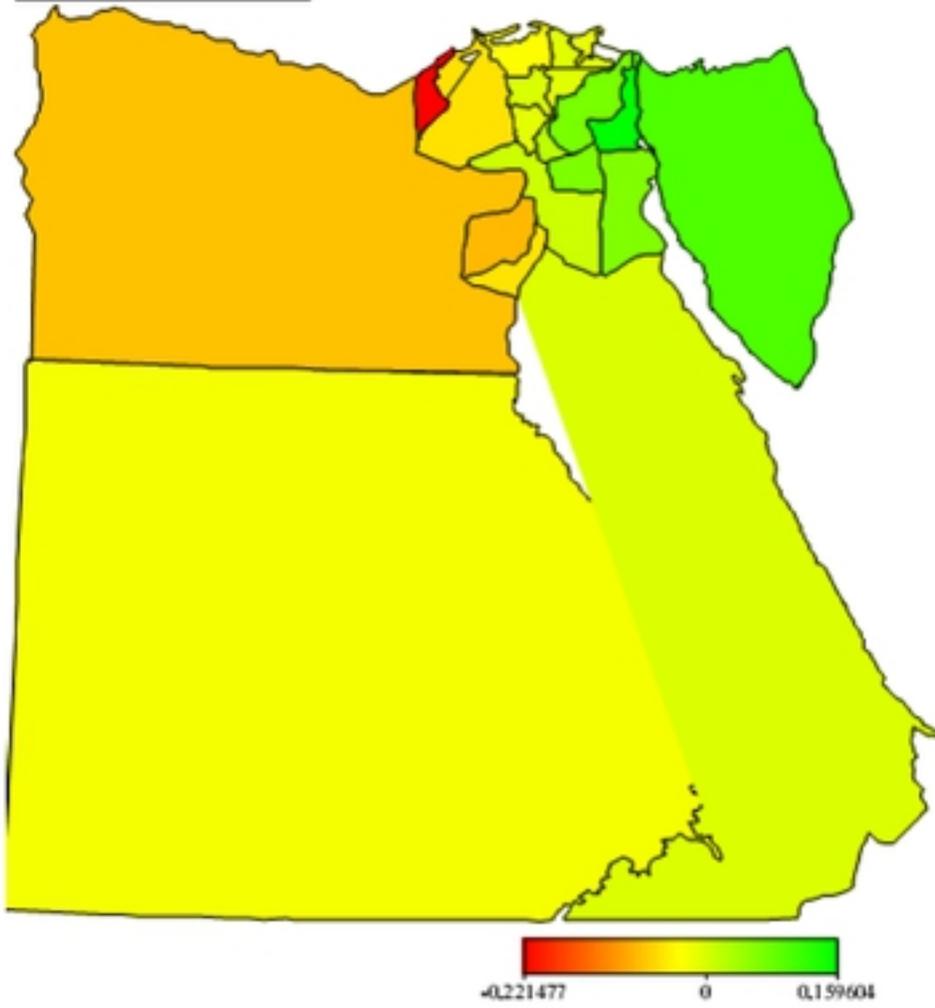540   S1 Data EDHS data 2014 on child labour

Governments

Urban

Rural

Household

Violent discipline approaches

Household work

Upper Egypt

Parental Survivorship

Child

Hazard Work

Mother Education

Father Education

Education

Household member

Sex

Age

Household size

Wealth index

Non-Hazard Wage Work

Lower Egypt

Figure

A:less than 16hrs a week

B:16-45hours a week
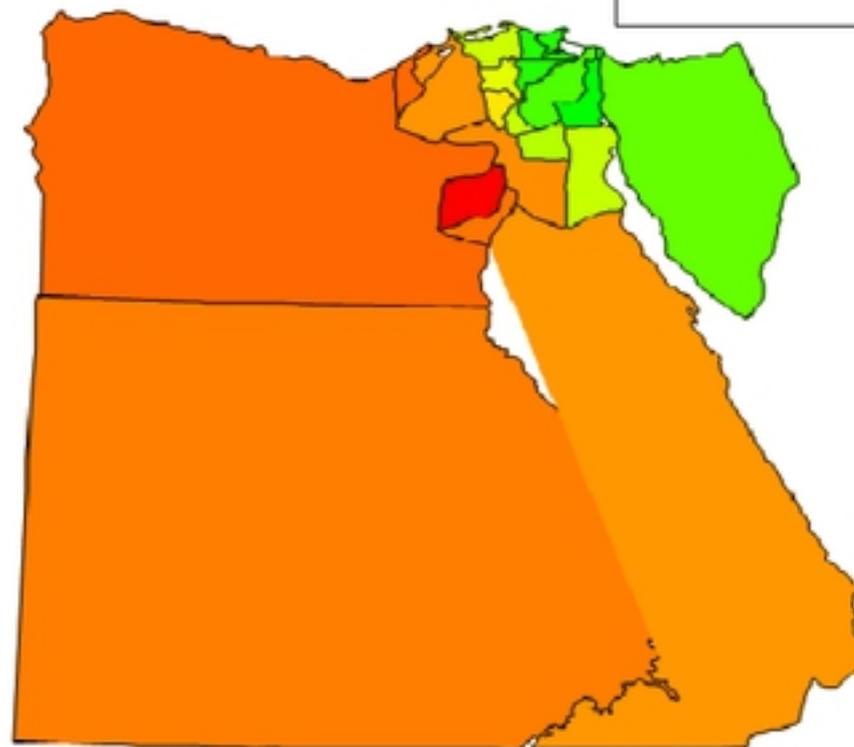
I.

Figure

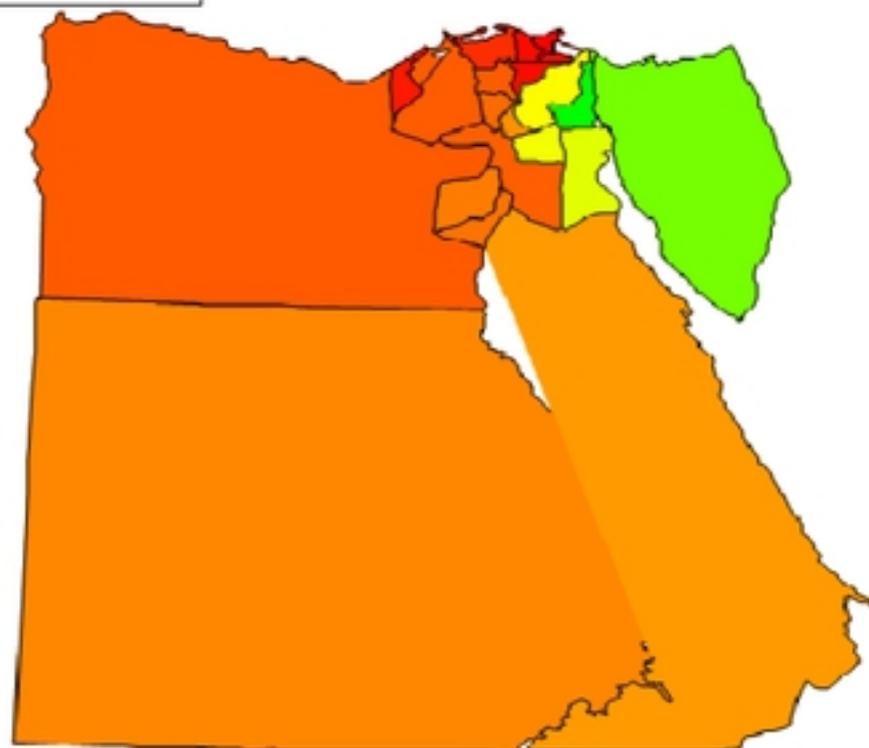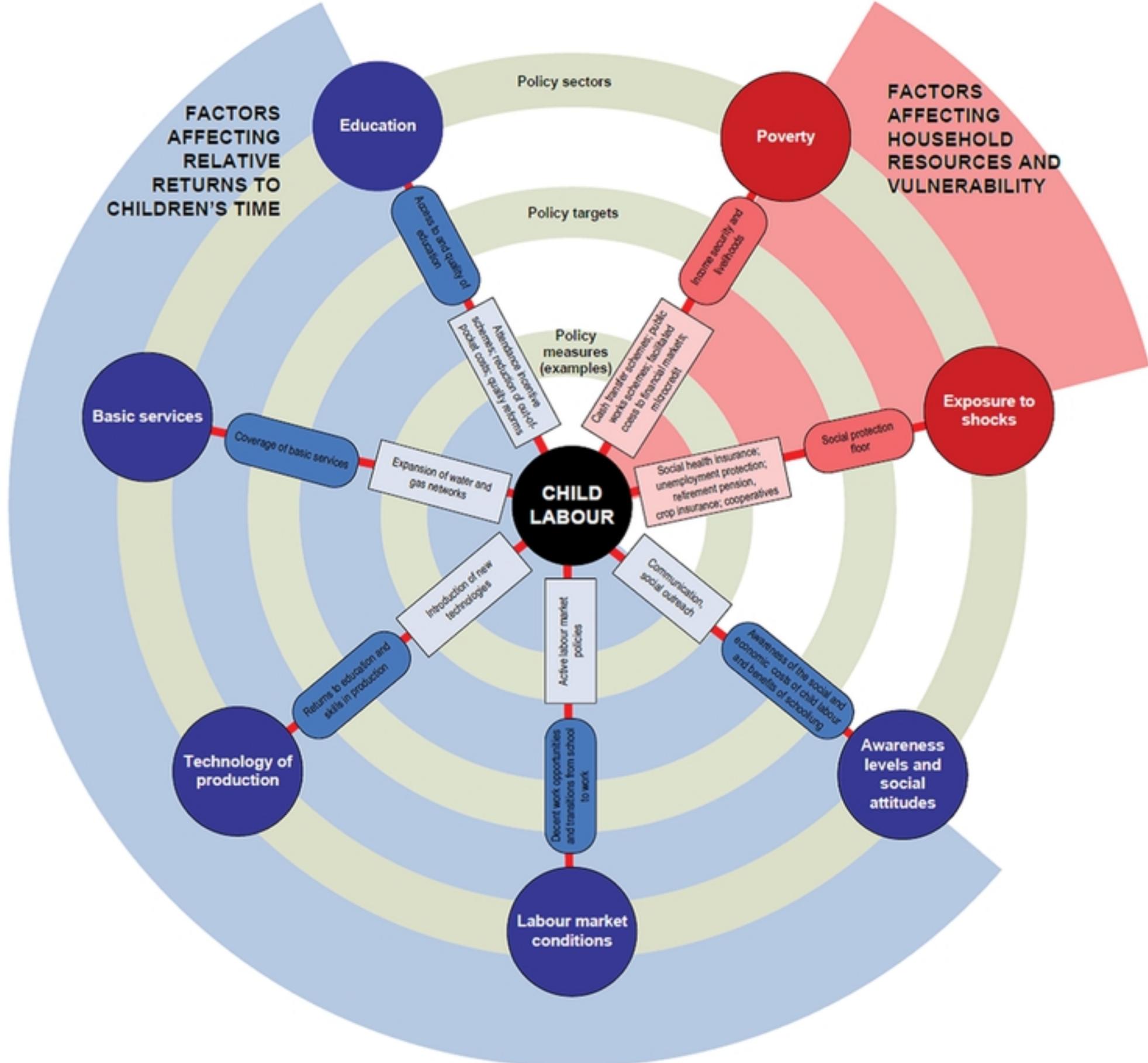A:less than 16hrs a week
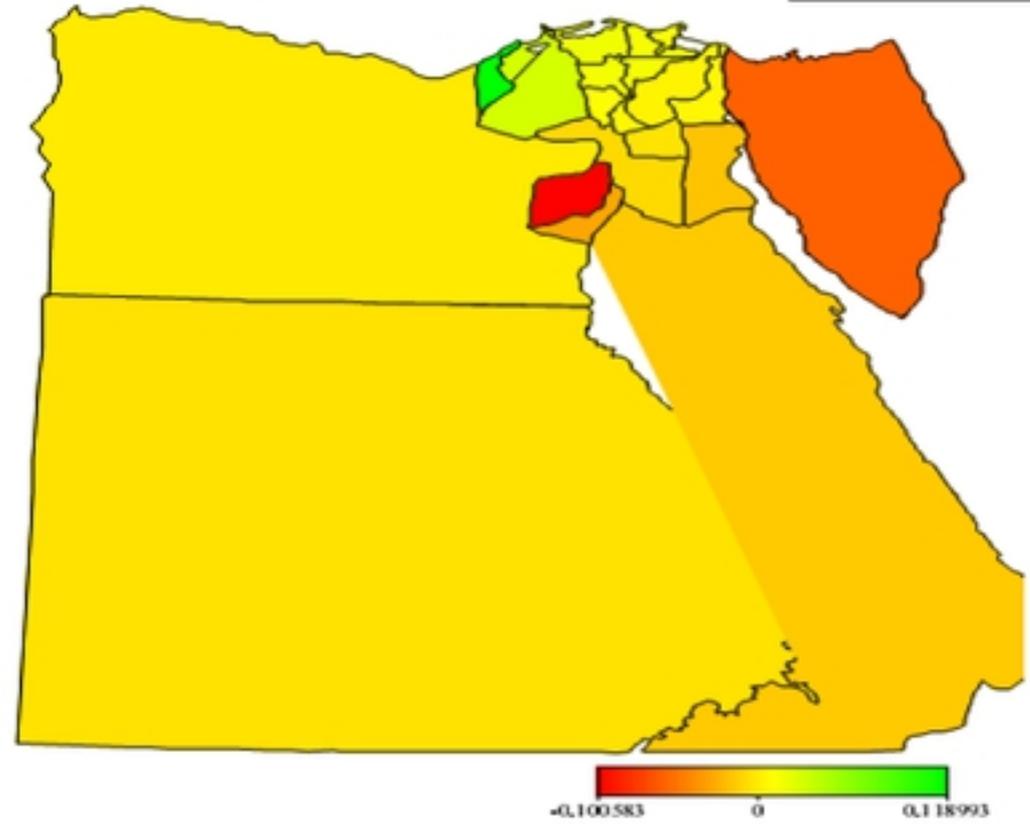
B:16-45hours a week

II.

Figure

A:less than 16hrs a week

B:16-45hours a week

III.

Figure

Figure