HUMAN FAMILY SIZE VARIES ACCORDING TO SOCIOECONOMIC STATUS: FROM NEUTRAL TO NEGATIVE RELATIONSHIP THROUGH THE FERTILITY TRANSITION IN SWITZERLAND

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ABSTRACT

Resource availability is one of the key factors that shape human evolution as life-history theory predicts that individuals with high resources produce more offspring. In humans, resource availability is closely linked to socioeconomic status, which may lead to variation in fertility (number of offspring) and ultimately affects fitness. However, how such associations have varied across demographic and economic development in societies is still unclear. Indeed, in contrast to predictions based on evolutionary theory, human family size began to decrease from high to low fertility and caused the fertility transition. In this study, I investigated the relationship between human family size and the socioeconomic status of individuals through time by using individual records of male fertility from a historical dataset from the 16th to the 20th century in the Swiss canton Glarus, including 15043 males. I used a sociological method for the historical social stratification system (HISCAM - Historical Social Interaction and Stratification Scales) to assign a socioeconomic score to individuals based on their occupation. Results suggest no significant relationship exists between family size and socioeconomic status before fertility transition. However, after fertility transition, if an individual's HISCAM score increases as 80%, his family size decreases as one offspring. Additionally, I showed that the paternal HISCAM score partially determines the offspring's HISCAM score, and the strength of this relationship decreases over the fertility transition, likely due to increased social mobility. The weak relationship between human family size and social class suggests that other social effects strongly impact human reproductive decision-making processes.

INTRODUCTION

Fertility transition is a decrease in birth rates from high to low by limiting the number of childbirths (van de Walle, 1992). This transition has resulted from the interaction of socio-ecological conditions and psychological processes that leads to parental investments (Kaplan et al., 2001). Furthermore, the decrease in fertility trends resulted in demographic transition caused by decreased fertility and increased longevity (Tulchinsky & Varavikova, 2014; van de Walle, 1992). Both of these transitions have begun in Europe and spread worldwide later on (Cummins, 2013). Research in fertility transition has taken attention from different disciplines such as evolutionary biology and social studies by looking at the causes and outcomes of fertility decline (Colleran, 2016; Liu & Lummaa, 2014; Sear, 2015; Stulp & Barrett, 2016). These fertility studies are linked with individual wealth differences and time. However, a multi-disciplinary study to disentangle both biological and social effects that caused fertility decline and resulted in fertility transition is still lacking.

Evolutionary approaches to investigating the fertility decline focuses on the ultimate reasons (Mace, 2020). For example, human behavioural ecology studies focus on the cost and benefit structure of fertility in different environments, mainly by focusing on quantity-quality trade-offs and their effect on the fertility decline (Lawson & Borgerhoff Mulder, 2016). As the number of offspring (quantity) is reduced, investment of the resources per offspring is increased and affects the fitness of offspring (quality) in the long term (Lancaster & Kaplan, 2010). A study from Iceland suggests the quantity quality trade-off impacted the demographic transition by showing that increased reproductive success decreases the offspring's fitness and lifespan, causing a decrease in fertility rates and leading to demographic transition (Lynch, 2016). Another study spanning four generations from Sweden after the demographic transition shows that low fertility is related to high social class (Goodman et al., 2012). Furthermore, a study from Antwerp investigated the heritability of social status by using a dataset spanning from 1846 until 1920 (Van Bavel et al., 2011). This study shows the relationship between a smaller number of offspring and an increased likelihood of the offspring remaining in the same social class, specifically for middle-class individuals. In contrast, individuals with more siblings are more likely to end up in a lower social class. Therefore, the quantity-quality trade-off is a widely used approach to investigate fertility decline from the biological perspective. However, it is not enough to assess the causations of fertility transition as social effects of modernisation should also be carefully considered in human behaviour (Lawson & Borgerhoff Mulder, 2016).

Fertility decline is investigated by social scientists by primarily considering the effects of modernisation on fertility trends by taking proximate approaches (Mace, 2020; Sear, 2015). Some studies about fertility transition highlighted the following historical facts such as the introduction of capitalism in Western countries enabled more women to work in the labour market (Folbre, 1983), increased more egalitarian family structures (Bras & Schumacher, 2019), and thus led to fertility decline (Kirk, 1996). Additionally, these mechanisms are enlightened and supported by the following social perspectives: Firstly, wealth–flow theory suggests that in traditional pre-industrial societies, children are considered the source to increase wealth since they are a production unit for the family, but in modern societies, children are considered an economic burden to the family as production occurs outside of the family and divided to the number of children (Caldwell, 1976).

Secondly, cultural evolutionists focus on how learning from one another as an adaptive behaviour might change human fertility (Colleran, 2016). This adaptive behaviour is also supported by mathematical models that show low fertility is favoured by the low mortality rate as reduced mortality allows low-fertility traits to become more abundant by cultural transmission advantage because of the higher social influence power the fast reproducers (Wodarz et al., 2020). Additionally, since modernisation, longer periods of a good education are required to achieve wealth, and this is more likely to happen in smaller families (Sear, 2015). For this reason, individuals copy the low fertility behaviour of wealthy individuals because of the prestige bias and thus increase the spread of the low fertility behaviour (Boyd & Richerson, 1985). Thirdly, the widening of social networks over time (from dense population networks within kins to extended networks) encouraged families to decrease the family size due to the reduced help from kin for childcare and increased social learning such as contraceptive usage (Newson et al., 2005). However, the increased availability of modern contraception is the outcome of the attempts to decrease fertility (Barkow & Burley, 1980; Hill & Kaplan, 1999; Santow, 1995).

Social studies explaining the causes of demographic transition still do not provide a multi-disciplinary mechanism, including evolutionary biology and social explanations, together by using genealogical datasets (Lawson & Borgerhoff Mulder, 2016). On the other hand, biological studies lacking to include social decision making processes for the low fertility behaviour (Sear, 2015). Due to the fact that wealthy individuals hold a strong power to influence the fertility trends in the population, as mentioned earlier, it is crucial to determine the wealth of historical families and their reproductive patterns are still needed to improve our understanding of human reproductive behaviour. In the end, the evolutionary puzzle for the causations of low fertility behaviour in wealthy individuals remains unsolved (Stulp & Barrett, 2016, p. 2015).

In this study, I use a novel approach by applying a historical social stratification system in an evolutionary biology study to link the historical fertility trends with socioeconomic status. Thus, I assigned a social stratification score to each individual based on their occupation and determined their social status by using HISCAM (Historical Social Interaction and Stratification Scales) scale, which is a sociological method that allows researchers to stratify social status in a natural continuous dimension (P. S. Lambert et al., 2013). As previous studies used social stratifications in categorical systems (Gillespie et al., 2008; Goodman et al., 2012; Liu & Lummaa, 2014), our dataset required a fine-scale approach that could take various occupations into account as it is substantial to clarify the variation. Additionally, the HISCAM score is an interdisciplinary well-documented approach used for various disciplines such as economics (Zijdeman & Lambert, 2010), intergenerational mobility studies (Thompson & Portrait, 2022), and other social mobility studies (Griffiths et al., 2019). In addition to the scale of the occupation as a proxy to social status, occupations are taken into account by using the HISCO (Historical International Standard Classification of Occupations) scheme, which is a fine-scale classification of the historical occupations derived from the International Standard Classification of Occupations (ISCO68) (Van Leeuwen et al., 2004). I investigate the association between human family size and the socioeconomic status of individuals by using a historical dataset that includes information from two parishes in the Canton of Glarus, Switzerland. The dataset spans 16 generations which include individuals who were born from the 16th to the 20th century. I predict that there is a positive relationship between family size and socioeconomic status before fertility transition and this relationship has turned negative after fertility transition. In other words, individuals with higher socioeconomic status that is estimated by a higher HISCAM score would have a smaller family size after fertility transition in contrast to the predictions based on evolutionary theory. Thus, I suggest that higher resources are not correlated with increased reproductive behaviour in modern populations; therefore, it might not be favoured by evolution. However, I expect that low fertility for wealthy individuals is a heritable and selected trait in the populations (Kim & Lee, 2019). Thus, I test my predictions for heritability by investigating if the socioeconomic status is partially determined by environmental factors such as parental socioeconomic status. Therefore, I investigate the association between of socioeconomic status of father-son pairs before and after the fertility transition. I hypothesise that the socioeconomic status of male individuals is partially determined by their father's socioeconomic status. Overall, individuals with more resources are expected to produce more offspring to increase their fitness, yet humans are expected to be under the strong influence of proximate mechanisms such as social norms. Therefore, it is predicted that social mechanisms and modernisation outweighed the evolutionary dynamics in human behaviour and resulted in fertility transition.

METHODS

Dataset

The dataset is derived from a genealogical archive (Kubly-Müller, 1912) for the Swiss canton of Glarus that contains detailed records of life history information about a population, such as birth, marriage, and family records (see Supplementary material). This study is conducted by only including individuals that are either born or wedded in two village parishes: Linthal (46°55'N, 9°E) and Elm (46°55'N, 9°10'E), and covered the individuals that were born earliest in 1549 and latest in 1949. Individuals born after 1949 are excluded from the analyses as they might not yet have completed their reproduction. The total number of individuals fulfilling these requirements is 32,820 (17736 female and 15043 male). For the entire study period and across all individuals, the median lifespan was 49.8 years. I expect that the dataset is representative of the central European society as the dataset contains information from Protestant and Roman Catholic parishioners as well as unbaptised individuals; therefore, the population is not expected to be highly homogeneous in terms of marriage age, the number of offspring, the most common occupations thus the wealth status (Evans et al., 2018). Additionally, the dataset contains detailed information about marriage status, children born outside of wedlock, and death records during early childhood.

Lifetime Reproductive Success

Individual reproductive characteristics are calculated by considering the life-history information and recorded as Lifetime Reproductive Success (LRS). LRS is estimated for all the individuals that are born in Linthal and Elm and only included documentation of their reproductive records in those parishes, including the ones who did not have any recorded offspring in those places, thus allowing the records to be consistent with the historical time stones and environmental factors in Glarus (Herrmann, n.d.). LRS is assigned as 0 to the individuals with a recording for either birth year or death year but no information for offspring. Focal individuals who did not reach adulthood are excluded from the analyses since high childhood mortality in the population would increase the 0 values in lifetime reproductive success and underestimate the reproduction trends in the population. Also, these individuals have not reached the adulthood age to receive a HISCAM score, and thus, they would be excluded from the model. Adulthood is defined as "reaching the reproductive age", and only adults are included in the model to assess the sample size initially. The reproductive age thresholds are set as 19 years for females and 21 years for males according to the sex-specific 5th percentile of age-at-first reproduction for the whole dataset (19.1 years for females, 21.15 years for males).

HISCAM Scale

Communities in historical Glarus have diverse occupations compared to many other historical populations (Liu & Lummaa, 2014); the most common occupations are farmers with no or little land, trained farmers, and weavers for women (for more, see Supplementary Table 1.). After the industrial revolution, textile factories opened in the regions (Laupper, 2017). As the population had a diverse range of occupations rather than an agriculture-based economy, the HISCAM scale system (Historical Social Interaction and Stratification Scales) (P. S. Lambert et al., 2013, p. 201) is applied to provide a stratification scale for each occupation. HISCAM is derived by using a sociological method called social interaction distance analysis that is applied for marriage registrations and inter-generational relationships from a historical dataset spanning from 1800 to 1938. This stratification system is generated by using the CAMSIS approach (P. Lambert & Griffiths, 2018) with a historical dataset and produces a natural single continuous dimension of social stratification with an empirical methodology by using a hierarchical scale. Universal HISCAM scales are calculated from four European countries (Belgium, Britain, France, and the Netherlands) where a greater variety of occupations are recorded, such as in Switzerland and therefore eligible to be applied for the universal analyses. Each historical occupation was assigned a HISCO code (Van Leeuwen et al., 2004) (henceforth *occupation ID*) according to the historical structrures, and each *occupation ID* received a factorial HISCAM value. It is assumed that wealth increases with the HISCAM scale. The reason the HISCAM scale is preferred to determine wealth is that HISCAM provides a fine continuous scale for various occupations rather than classifying the wealth status by grouping individuals according to their socioeconomic status. HISCAM scale in the dataset varies between 39.90 (which is assigned for the occupations such as servants, maids, and carpenters) and 99 (which is assigned for pastors, lieutenants, university graduates, professors, and managers, for more, see Supplementary Table 1). The distribution of the various HISCAM scores within the dataset is shown in Figure 1. The dataset contained 8528 individuals (7332 males and 1196 females) with a recorded HISCAM score. However, data is a subset for model comparisons. Only 6535 male individuals contained *family ID* (derived from *father ID*) and *occupation ID*. For the statistical analyses, I applied proportional data transformation for the HISCAM scale by dividing each score in the overall distribution by 100 for better visualisation of the raw data, therefore Proportional HISCAM Scores (min value=0.39, max value=1, factorial) are obtained both for focal individuals and fathers.

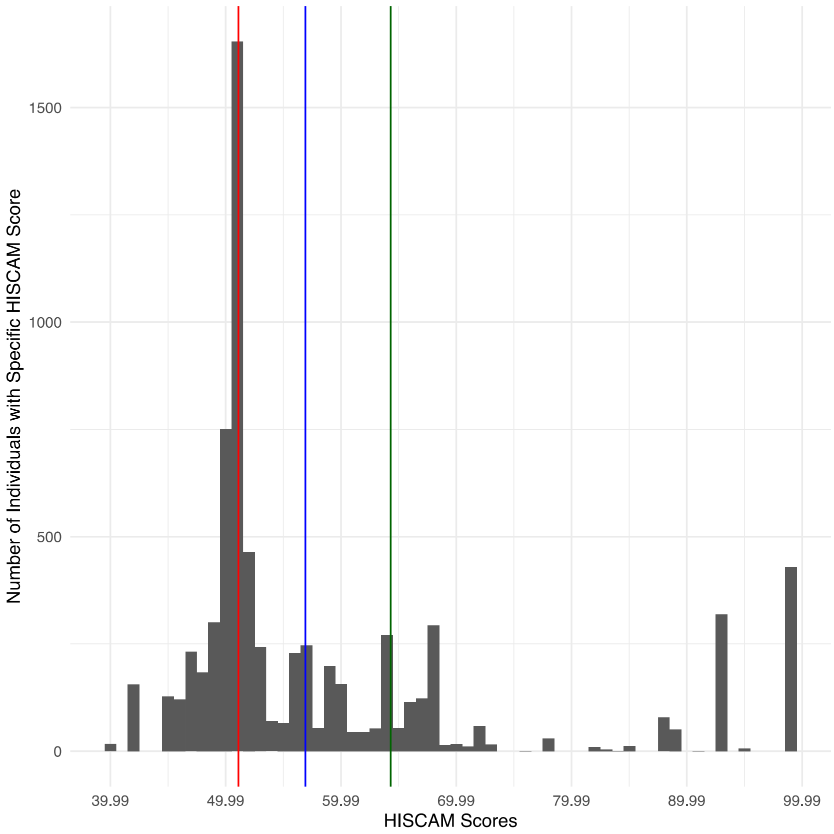

Figure 1 Histogram of the HISCAM scores of males. The Red line represents the HISCAM scores given mostly to the farmers; the blue line represents the HISCAM scores given mostly to the mechanics; the green line represents the HISCAM scores mostly given to the merchants.

Fertility Transition

Fertility transition is the decrease in family size that results from high fertility to low fertility change in humans (van de Walle, 1992). Therefore, the fertility transition in Glarus is estimated according to the dataset's structure. Individuals born in 1835 or later with a recorded occupation had lower lifetime reproductive success compared to the previous generations (Figure 2). As they reached their reproductive ages later, I set the fertility transition threshold as 1865. Additionally, sensitivity analysis is applied to assign an accurate threshold. Therefore, models run different fertility transition thresholds every five years from 1850 until 1900. It is seen that the effect of fertility transition on lifetime reproductive success is the same direction after 1865.

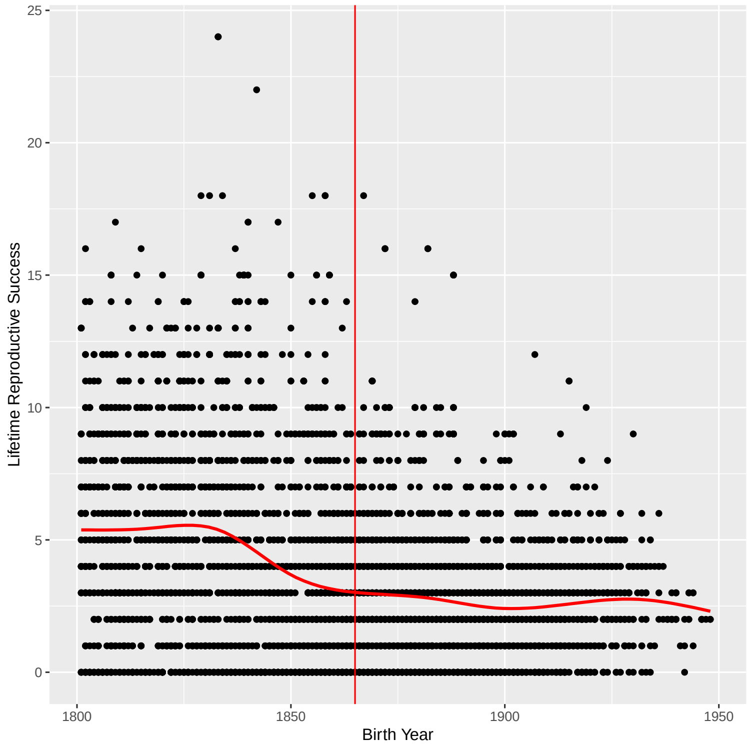

Figure 2 Decrease in Lifetime Reproductive Success in time for the individuals with an assigned HISCAM Score from 1800 to 1950. The vertical red line indicates the fertility transition threshold set for 1865.

On the other hand, the estimated threshold from the fertility decrease is also supported by the historical changes in Glarus (Laupper, 2017). Historical changes such as the developed industry in the region (Herrmann, n.d.) that improved the labour market for women, thus played a role on decreasing the fertility rates, improved railways also improved the social networks, bans of child labour that decreased child mortality rates then altogether influenced the demographic transition (Cervin, 1953). These processes accumulated throughout the 19th century, resulting in the fertility transition around 1865. Therefore, fertility transition in all the statistical analyses below is represented as a new variable called "transition" and contains a binary structure (0 for the individuals born before 1865; 1 for the individuals born after 1865). Individuals born before 1865 are recorded as born before the transition period (sample size is 3817) and individuals born after 1865 are considered born after the transition (sample size 2291). However, it should be noted that age at first reproduction for the latter is later than 1865 (mean value for age at first reproduction is 24.43 for females; 27.21 for males).

Statistical Analyses

I used a generalised linear mixed model (GLMM) to examine the relationship between social status (determined by HISCAM score) and family size to estimate the selection of smaller family sizes in higher social classes. LRS is used as a family size proxy and as a response variable in the main model. Only males have been included in the analyses because only a few women in the population had an occupation of their own, hence females could not be assigned a personal HISCAM score (Supplementary Table 1). All analyses are completed in R 4.2.0 (R Core Team, 2022) by using *lme4* version 1.1-29 (Bates et al., 2015) for the model. Model comparisons are applied, and p-values are calculated by *lmerTest* version 3.1-3 (Kuznetsova et al., 2017). Models are controlled with *blmeco* version 1.4 (Korner-Nievergelt et al., 2015) for overdispersion, and no overdispersion is detected. Figures are generated by using *ggplot2* version 3.3.6 (Wickham, 2016). The significance of the effects is evaluated according to the p-value lower than 0.05. The final model contained 5829 male individuals. The transition variable is included as an interaction effect to the response variable (hiscamP* transition) to test the prediction that the HISCAM score is differently associated with the family size before and after the fertility transition. The model is analysed using GLMMs with a Poisson error structure, and log link function since the response variable had a Poisson distribution.

The model also included random effects such as *family ID* (2131 distinct groups) and *occupation ID* (192 distinct groups) to assess the random effects of each occupation and *family ID*. *Family ID* and *occupation ID* are chosen as random effects for two reasons: firstly, they both might cause variation in the response variable (LRS), but they are not of direct interest (O'Hara, 2009); secondly, they decrease the deviance in the model. Therefore, each random effect is tested by the Chi-square test and terms are added accordingly only if they significantly decrease the deviance by ANOVA model comparison. Further controls are also applied by considering the addition of other fixed effects, such as birth location and marriage location, as regional patterns might affect the family size. However, these effects are not included in the main model since HISCAM and *occupation IDs* already account for the location; in other words, individuals within a specific region tend to have similar occupations and scores.

Additionally, one of the determinants of socioeconomic status (shared environment between parent and offspring) is investigated by using a linear regression model to investigate the resemblance of socioeconomic status of the father and focal individual (son). Therefore, the model contained the focal individual's HISCAM score as a response variable and the father's HISCAM score with the interaction effect of fertility transition (hiscam_fP*transition) as an explanatory variable.

RESULTS

I estimated the relationship between the lifetime reproductive success (LRS) and socioeconomic status of 5829 male individuals from the Swiss canton Glarus. I additionally estimated the decreased trend of the existing resemblance between the socioeconomic status of father and son after the fertility transition for 5213 father and son pairs. Individuals are born between 1549 and 1949, either born (sample size for Linthal is 2730; for Elm is 3125) or married in one of the parishes (sample size for Linthal is 2703; for Elm is 3103).

Relationship Between Human Family Size and Socioeconomic Status

The model contained 3620 individuals born before the fertility transition and 2209 individuals born after the fertility transition. The model estimated the association between family size and socioeconomic status before and after the fertility transition. There is no significant association between family size and socioeconomic status before the fertility transition detected (Table 1). Secondly, model results show that for the individuals born after the fertility transition, socioeconomic status is negatively associated with family size (Figure 3). However, this very small association (Figure 4) could be described as if an individual's HISCAM score increases by 48 points (80%), he is likely to have one less offspring. This increase could be further expressed as the socioeconomic mobility between a servant (HISCAM score=39.90) and an architect (HISCAM score=85.37) or a factory owner (88.22). Model results also show that individuals born after fertility transition had smaller families (Table 1). The decrease in family size could be described by a 2.75 decrease in the mean values of LRS before and after the transition (the mean value before fertility transition is 5.55 after the fertility transition is 2.75). Also, there is a significant variation associated with fertility rates and occupation and family ID (Table 1).

Table 1. Model results for the association between Lifetime Reproductive Success (LRS- response variable) and HISCAM score with the interaction effect of the fertility transition (explanatory variable). Transition refers for if individual born before or after the transition (1865) without any interaction effect of HISCAM. Model included random effects occupation ID and Family ID.

Fixed Effects	Estimate	X^2	Degrees of freedom	p-value
Pre-transition	-0.03 ± 0.17	-	-	= .88
Post-transition	0.46 ± 0.2	4199.5	2	**< .001**
Transition	-0.32 ± 0.11	317.26	2	**< .001**
Random Effects	variance	X^2	Degrees of freedom	p-value
Occupation ID	0.04	116.08	1	**< .001**
Family ID	0.35	4165.5	1	**< .001**

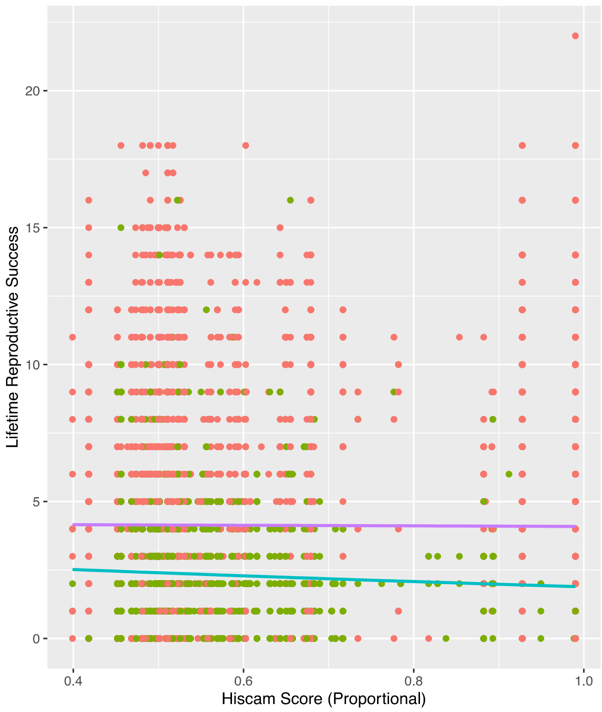

Figure 1 Negative association between HISCAM (divided by 100, on the x-axis) and Lifetime Reproductive Success (y-axis). The purple line shows the LRS when HISCAM is increasing for the individuals born before the fertility transition (non-significant), and the blue line shows the association between LRS and HISCAM for the individuals born after the fertility transition. Red dots represent the individuals born before the transition (1865) green dots represent the individuals born after the transition.

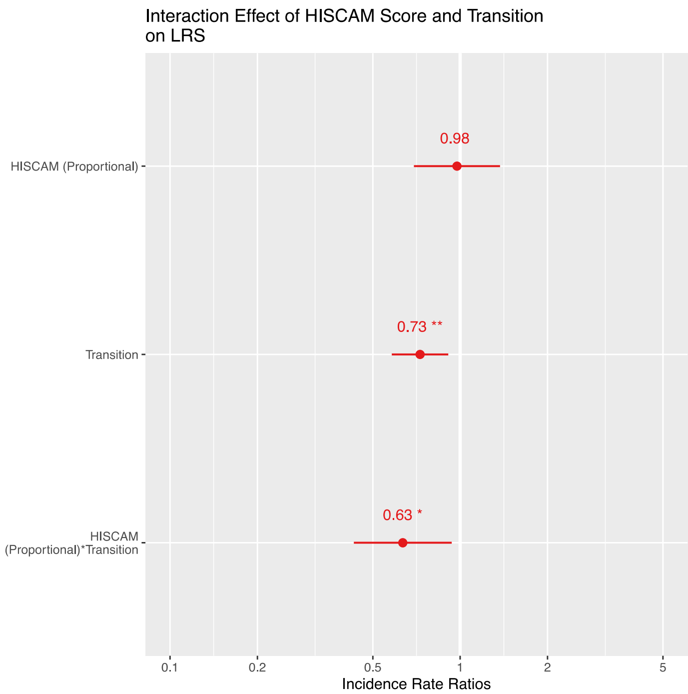

Figure 2 Incidence Rate Ratios for the first model indicate the association between family size (LRS) and socioeconomic status (HISCAM) before and after the fertility transition. The significance of the relationship between birth year (transition) and

The model results provide evidence for the association between family size and socioeconomic status, which is shifted from neutral to negative after the fertility transition in Glarus.

The Resemblance of The Socioeconomic Status Between Father and Son

A complementary model is designed to investigate if the focal individual's (son) socioeconomic status is partially determined by his father's socioeconomic status. Model results showed a positive association between the paternal socioeconomic status and the focal individual's socioeconomic status (Figures 5). However, this association significantly decreased (Table 2) for the individuals born after the fertility transition. Nevertheless, the decrease is quite small. If the father has the highest socioeconomic status, the focal individual likely to remain in a similar socioeconomic status. Additionally, the individual's birth year has no significant effect on the individual's socioeconomic status since “Transition” has no significant effect on the focal individual's HISCAM score. Therefore, an individual's socioeconomic status is not partially determined by the time) that individual is born (before fertility transition or after fertility transition.

Table 1 Model results for the socioeconomic status “resemblance” linear regression model of the father and the focal individual pairs. HISCAM score of focal individuals is the response variable and HISCAM score of the fathers with the interaction effect of Transition is the explanatory variable. Pre-transition refers to the association between father and son pairs if the focal individual (son) is born before the fertility transition (1865), and post-transition refers to if the focal individual is born after the fertility transition.

Fixed Effects	Estimate	X^2	Degrees of freedom	p-value
Pre-transition	0.38 ± 0.01	0.61	1	**< .001**
Post-transition	0.29 ± 0.03	0.12	1	**= .01**
Transition	0.02	-	-	> .05
$R^2 = 0.167$				

Figure 3 Illustration of the Resemblance Model showing the association between the father's HISCAM Score (x-axis) and the focal individual's HISCAM score (y-axis) before the fertility transition (pink) and after fertility transition (blue) according to the birth year of focal individuals (1865).

DISCUSSION

This study investigates the relationship between socioeconomic status and family size in humans both before and after a major decline in the fertility rate of the historical Glarus population. It is predicted that the association between human family size and socioeconomic status would turn from positive to negative after fertility transition. The positive association between human family size and socioeconomic status is hypothesised based on the predictions stated by the evolutionary theory, as individuals with more resources would produce more offspring to increase their fitness (Barkow & Burley, 1980; Livi-Bacci, 2017). Even though this positive association is reported in different European populations before modernisation (Cummins, 2013; Liu & Lummaa, 2014; Skirbekk, 2008), there is no significant relationship found before the fertility transition in Switzerland. However, a negative association between human family size and socioeconomic status after fertility transition is shown in Switzerland. This negative shift as high-class individuals began to have smaller families after the industrial revolution matches previous findings from other European countries (Cummins, 2013; Skirbekk, 2008). Lastly, the study provides evidence that males' socioeconomic status is partially determined by paternal socioeconomic status.

The results of this study outline historical family trends in the Swiss Canton of Glarus by showing that high-class individuals did not aim to increase their family size before the fertility transition. Also, individuals with low socioeconomic status did not attempt to limit or increase the number of offspring before industrialisation. The absence of association between family size and socioeconomic status before the fertility transition might be caused by numerous reasons. Firstly, there was no food scarcity in the population to encourage individuals with low socioeconomic status to have fewer children compared to previous studies, such as in pre-industrialised Finland, rural populations in France before the French revolution, or in a rural Kenya population (Cummins, 2013; Liu & Lummaa, 2014; Shreffler & Nii-Amoo Dodoo, 2009). Secondly, the individuals from lower social class or farmers (as one of the most common occupations, see Supplementary Table 1 and Figure 1) might tend to have more children to increase the production within the family (Caldwell, 1976) due to the common child labouring in the region (Herrmann, n.d.). Thirdly, in traditional European societies, family size limitation attempts could be mostly followed by high-class individuals (Livi-Bacci, 2017, p.); therefore, individuals with low socioeconomic status might not be able to reach the resources and information to limit the number of children in Glarus. Last but not least, the association between high social mobility and low fertility is determined in both demographic and social studies (Coale, 1986; Cummins, 2013; Gillis et al., 1992). Social mobility was lower in Glarus before the fertility transition; thus, adjusting the family size would not be aimed at individuals with low socioeconomic status since individuals could not change socioeconomic status only by adjusting their family sizes as suggested by prestige bias (Boyd & Richerson, 1985). Furthermore, lacking social mobility before the transition could be linked to high economic inequality in the population (Cummins, 2013). However, these neutral associations between socioeconomic status and family size became negative after the fertility transition.

It is predicted that individuals with higher socioeconomic status tend to have smaller family sizes after industrialisation, which leads to the fertility transition, as shown in previous studies (Cummins, 2013; Skirbekk, 2008). Furthermore, smaller family size is for families with higher socioeconomic status since they have more resources contrasts with the predictions based on evolutionary theory (Barkow & Burley, 1980; Livi-Bacci, 2017). However, this study provides clear evidence by showing the negative association between family size and socioeconomic status after fertility transition in a Central European population as a worldwide trend (Goodman et al., 2012; Livi-Bacci, 2017; Lynch, 2016) to my knowledge; no one has done it in such a large dataset. Although, it should be noted that this effect size is quite small, as the possibility of shifting socioeconomic status dramatically in historical populations is debatable (Marco H. D. van Leeuwen & Maas, 1997).

Additionally, this study investigated if the socioeconomic status is partially determined by paternal socioeconomic status. Thus, a resemblance between the paternal HISCAM score and the focal individual's HISCAM score is determined. Furthermore, it can be said that the negative association between family size and socioeconomic status is heritable due to the resemblance between the father's socioeconomic status and the son's socioeconomic status. However, this association decreased after the fertility transition due to the increased intergenerational mobility which occurred after fertility transition. In other words, increased social mobility allowed individuals to have different occupations than their fathers and this change in occupation might lead to a decrease in family sizes. Additionally, increased social mobility provides evidence for the decrease in social inequalities in the population (Cummins, 2013), expected as one of the outcomes of industrialisation. This could shortly be referred as modernisation in Europe, and it is also used to assess the fertility transition threshold as 1865. Furthermore, these social factors altogether affect family structures by increasing women's work labour in the region (see Supplementary Table 1) by improved textile industries (Folbre, 1983), which might have led to the improvement of more egalitarian family structures (Bras & Schumacher, 2019), widening social networks (Munshi & Myaux, 2006), therefore, increasing the possibility of learning birth controls and decreasing kin help for childbearing (Newson et al., 2005). Overall, many different social factors might be affecting human fertility behaviour in Glarus, resulting in increased social mobility, and leading to an essential decrease in the family sizes (Kirk, 1996). Also, the overall decrease in family size, whereas this decrease happened more for the individuals with higher socioeconomic status, could suggest that family size limitation has been initiated by high social class individuals and mimicked by individuals with lower socioeconomic status after modernisation (Boyd & Richerson, 1985; Livi-Bacci, 2017, p.).

This study has several limitations. First, family size is determined by using lifetime reproductive success as a proxy and only covered the reproduction scores in Linthal and Elm. Even though the population does not have high emigration trends before marriage (see Supplementary “analysis.rmd”), it is still possible for individuals to move away from their birth city and increase their lifetime reproductive successes later on. Additionally, it is important to take emigration and immigration into account, as previous mathematical models show that low reproductive rates are linked with population density (Wodarz et al., 2020). Therefore, further studies could investigate the family size decrease while accounting for the migration trends in the population. In addition to these, heritability of the lands between father and children should be carefully considered in further analyses as they could have a similar impact on the results as food scarcity (Mulder, 2000; Shreffler & Nii-Amoo Dodoo, 2009). Secondly, I could only include male individuals since females born before the 19th century did not have their own occupations and therefore lacked a HISCAM score. This limitation could be overcome by assigning a HISCAM score to the female individuals according to an assessment of their paternal and marital HISCAM scores. Additionally, the HISCAM score itself has its limitations. Even though it is a detailed continuous scale, most of the individuals in the dataset had a HISCAM score between 39.90 and 70 and a gap between 70 and 99. The dataset structure was also similar to the dataset from which universal HISCAM is derived (P. S. Lambert et al., 2013). Even though I transformed the HISCAM by dividing it by 100 for better visualisation, the non-existence of factorial scores in a continuous dimension might slightly affect the outcome. A comparative approach between HISCAM and different classifications of socioeconomic status might account for the unique dataset structures. On the other sides, this genealogical dataset contains the life-history records of a population that lived in small villages and spans about 400 years. Additionally, the dataset is derived from church records which provide more complete information about life-history traits compared to state records (Van Leeuwen et al., 2004); this includes the recordings of the number of children born outside of marriage. Overall, this genealogical dataset has a novel and well-recorded structure for accurate statistical analyses to estimate human evolution.

In conclusion, this study aims to cover the gap in the literature by producing statistical results with predictions based on evolutionary theory and supported by the social structures of a population from Switzerland. Furthermore, sociological methodologies are applied to investigate the family structures, including interdisciplinary tools and results are aimed to be explained by considering the social impacts on human behaviour. Consequently, these findings show that family size decreased for individuals with higher socioeconomic status after the overall decrease in fertility, and this might not be a favourable trait in evolutionary terms but provides clear evidence for the strong social impacts on the reproductive decision-making process of humans.

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SUPPLEMENTARY MATERIAL

Table 2 Most common occupations in different centuries, including number of individuals who had specific occupation and HISCAM score of the occupation

Most Common Occupations in Different Centuries

Century	Number of Individuals	Occupation	HISCAM
16	2	Councilor	99.00
	1	Church vogt	67.9
17	48	Tagmenvogt	92.8
	40	Church meier	67.9
18	146	Farmer (no land)	51.1
	81	Tagmenvogt	92.8
	55	Watch master	52.4
	50	Day laborer	41.8
19	449	**Farmer (no land)**	51.1
	424	**Weaver (female)**	45.2
	401	Trained farmer	51.1
	234	Field worker	50.1
20	305	**Trained farmer**	51.1
	62	Mechanic	56.9
	60	Merchant	64.3
	50	Chauffeur	49.8

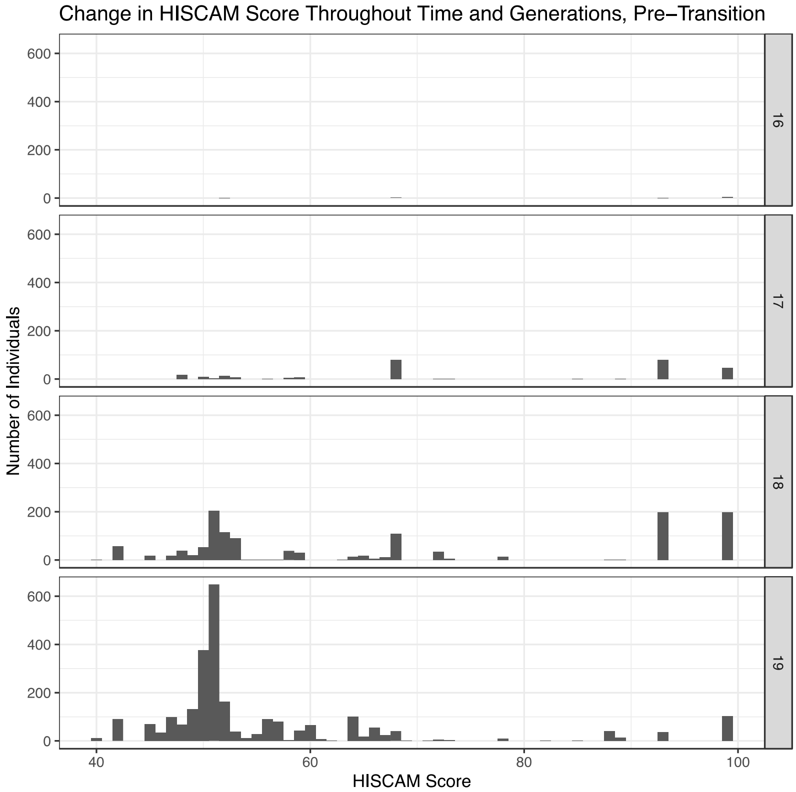

Figure 4 Number of Individuals with different HISCAM Scores throughout different centuries. Data only includes male individuals that were born before the fertility transition (1865).

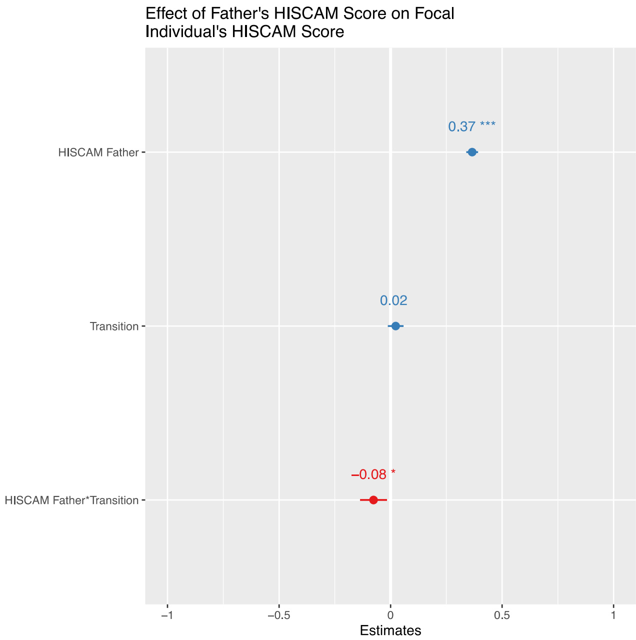

Figure 5 Estimates of the Resemblance linear regression model showing the estimates for the association between focal individual's HISCAM score (response varible) and father's HISCAM score with the interaction effect of transition (explanatory variable).