Journal of Biosocial Science (2023), 55: 5, 893–907
doi:10.1017/S0021932022000396

CAMBRIDGE UNIVERSITY PRESS

RESEARCH ARTICLE

Studying the seasonality of conceptions among five distinct population subgroups in mainland Greece: a story of similarities and variability

K. N. Zafeiris[1]*, C. Tsimbos[2], G. Verropoulou[2] and K. Hatzisavva[1]

[1]Laboratory of Physical Anthropology, Department of History and Ethnology, Democritus University of Thrace, O. Tsaldari1, Komotini 69132, Greece and [2]Department of Statistics and Insurance Science, University of Piraeus, 80, M. Karaoli & A. Dimitriou St., Piraeus 18534, Greece
*Corresponding author. E-mail: kzafiris@he.duth.gr

(Received 30 March 2022; revised 22 July 2022; accepted 5 October 2022; first published online 20 October 2022)

Abstract

The paper studies seasonality of conceptions among five distinct population subgroups of mainland Greece for the period 1951-2002. The populations explored include those residing in Metsovo, Dion, Organi, Kehros, as well as a "General" Sample consisting of persons located in various areas of continental Greece. The populations under investigation present diverse characteristics regarding religion, cultural background, socio-economic status etc. Records of births were derived from the Vital Registration System of the respective municipalities and communities of the populations under research were constructed. The date of child conception was estimated as the recorded date of birth minus 260 days.

The analysis focuses, among others, on the construction of seasonal indices, applying a variant ratio to moving averages method which reveal, in relative terms, the seasonality of the phenomenon. Subsequently, these ratios are considered as the dependent variable in regression models while months, expressed in terms of dummy variables, are introduced as predictors. Four main sub-periods are considered; 1951-64, 1965-80, 1981-92 and 1992-2002. The findings show that the extent of seasonality differs between periods as well as between the five population subgroups though the phenomenon becomes less prominent over time in all cases. There is a tendency of an increased number of conceptions among mountainous populations during summer, irrespective of religion or socio-economic status, possibly partly due to environmental factors (i.e. seasonal workload, domestic organisation of extended families, etc). Nevertheless, the mountainous populations differ regarding the intensity and duration of this phenomenon. By contrast, in Dion, a lowland Christian Orthodox population, conceptions increase after Easter and remain elevated until June.

Keywords: seasonality; conceptions; variability; Greece; population subgroups

Introduction

The number of conceptions and births follows a seasonal, cyclical, but usually fluctuating pattern over time, influencing even the characteristics of later life (Didikoglu et al. 2020). It is a global phenomenon observed both in contemporary and historical populations (see Quételet 1826; Lam and Miron 1991), including the natural fertility ones, like the Old Order Amish (Greksa 2004) or the Hutterites. In the latter case, the conceptions increased from December to June and declined from July to November (Surbey et al. 1986). Overall, the seasonality's diversity is substantial all over the world. In the United States, there was a peak in births during September and another one during April-May (Lam and Miron 1991). This general pattern

depended on the latitude: the northern states exhibited a spring/summer peak while the southern states an autumn peak (Martinez-Bakker et al. 2014). Some differences existed in England and Canada, concerning mainly spring months (Lam and Miron 1991).

According to the Lam and Miron (1991) classification, a "European pattern" of seasonality of births emerged in the past, corresponding mainly to Western European countries, consisting of *"a global spring peak, a local September peak, and a significant trough during the late fall and early winter"*. In central and southern Europe, where seasonality was less pronounced, the local September peak persisted, and the decrease in the number of births was observed from October to January. In India, the diversity was high, while in Japan, the seasonality had more affinities with the North American and European populations. More details can be found in Lam and Miron (1994). In more recent studies, the number of births is higher from February to April in northern and South Australia, but, in the southeast, the peak comes in September-October (Wilson et al. 2020). Singh et al. (2020) discovered two general patterns (1990-2005) for India; the first corresponds to a conception excess from October to February (Uttar Pradesh), while in Kerala, a peak exists in July-August. In Sweden, the high number of births during spring was followed by low numbers in the last quarter of the year (Dahlberg and Andersson 2018).

Seasonality patterns do not remain stable over time. In Poland, for example, the pattern of a spring peak and a local excess in September remained unchanged for a long period (1950-1989). In 1990-2009, however, a new pattern emerged, with birth peaks in July and September (Cypryjański 2019). In Malta, patterns altered following the introduction of contraception in the 1960s (Grech et al. 2003). In Sweden, the seasonal variations of birth rates declined significantly during the 21st century (Dahlberg and Andersson 2018). In France, the historical September birth spike, corresponding to a peak of conceptions in New Near's Eve, is the only one that still stands out among the low-amplitude seasonal variations (Régnier-Loilier 2010). Overall, as Roenneberg (2004) suggests, human seasonality has declined in the recent era. The human reproductive cycles are either an adaptation to the seasonal cycles or subject to cultural factors (Wood et al. 2017). Many environmental, social, and biological agents affect them (see Doblhammer-Reiter et al. 2000), including several sociodemographic variables, like maternal age, marital status, education and birth order (Bobak and Gjonca 2001; see also Lummaa et al. 1998; Surbey et al. 1986; Cypryjański 2019; Yang 2021).

Among the essential sociocultural determinants are the religious festivities, holidays and sexual activity cycles, which, along with fecundity, vary in a year. In the USA, an increase of conceptions occurs around Christmas, but not in the summer (Lam and Miron 1991). By contrast, in England and Wales, sexual activity increases during summer, besides the Christmas effect on conceptions (Wellings et al. 1999; Hennink et al. 2000). In Croatia, a similar positive effect of Christmas on conception rates is found (Polašek et al. 2005). However, the "Christmas effect" has disappeared in Sweden after the 1990s (Dahlberg and Andersson 2018). Other religious obligations may restrict human sexuality in a year. In Spain, for example, it was found that conceptions decreased significantly during Lent (Simó-Noguera et al. 2020). In Romania, the fasting periods and the religious affiliation are essential factors regulating the date of conception (Herteliu et al. 2015). In Malta, the late summer peak is related to contraceptive planning, which in its turn is affected by the Roman Catholic ethos and social pressures (Grech et al. 2003). Thanksgiving day increased coital frequency in the Old Order Amish (Greksa 2004). Therefore, these events may either boost or depress sexual activity and conceptions in a year.

There is evidence that several ecological/climatic factors may affect the frequency of sexual intercourse. As Darrow et al. (2009) suggest, the hot weather in the summer may reduce conceptions through reduced coital frequency or decreased fecundability (e.g., decreased sperm quality; see also Yang 2021; Greksa 2004). Seasonal variations in fecundability have also been found elsewhere, with a peak in the late autumn and early winter (Wesselink et al. 2020). In Australia, the hot and humid summers in the north, and the cold winters in the southernmost parts of the country reduce the number of conceptions below their regional averages for the year (Wilson et al. 2020; see also Cornelisse et al. 2016). In other studies, the effect of photoperiod or light intensity is emphasised (Cummings 2007; Darrow et al. 2009).

https://doi.org/10.1017/S0021932022000396 Published online by Cambridge University Press

Indeed, other factors contributing to the annual birth pattern -besides photoperiod- can lead to changes in the coital frequency in a multivariate scheme, including, as said before, holidays, seasonal patterns in fetal loss, and seasonal preferences in pregnancy planning (Darrow et al. 2009). Seasonal variation of workload must be also included among them. In Italy, the intensity of the agricultural workload varies significantly in a year and becomes more intense in the summer, primarily when grain was harvested without sufficient nutrition (Ruiu and Breschi 2019). Roenneberg (2004) recognises a combined effect of industrialisation, microclimate and human behaviour on human conception rhythms and seasonality, because after the "*shifting work from outside to inside, both the daily and the annual changes of light and temperature are drastically buffered.*"

Any relevant publications are scarce in Greece. Krassas et al. (2007) recognise that in the general population of Greece, the number of births increases during summer, which gives a rise of conceptions during the autumn and the first month of winter. Gavalas (2009) found that in two villages of Paros (Naoussa and Kostos), conceptions were high in the summer and September, reduced towards November, and increased until February. Zafeiris (2012), found a high but changing seasonality of births and conceptions among the populations under investigation. More specifically, in the Vlachic population of Karitsa until 1979, the number of conceptions increased in May and remained above average until July. Afterwards, seasonality declined. In the Pomaks of Rhodopi, there was an excess in conceptions lasting from June to September. These temporal trends are connected with the annual religious calendar, cycles of agriculture and other factors.

Thus, the main research question in this paper concerns the seasonality of conceptions (and thus births) in 5 mainland populations. The scope is to identify general patterns of sexual behaviour and fecundability throughout a year and to examine the existing heterogeneity, i.e. possible convergences and divergences among these populations. Further, as we approach the modern era, the second topic of interest is to observe changes in the seasonally of conceptions (births) that occurred over time.

The main characteristics of the populations under study are described in Table 1. Five populations with significant similarities and differences are considered. Three of these are mountainous. One of these, the population of Metsovo, is of Vlachic origin, and is located in the Pindus Mountains. Metsovo is one of the metropolises of Vlachs in Greece, respresnting a well developed region in the past compared to the other four populations (see Zafeiris et al. 2015). The other two mountainous populations are residing in Organi and Kehros and come from the Rhodopi mountain in the homonymous Department of Eastern Macedonia and Thrace (Zafeiris 2020). These are Pomak populations. The fourth population is a lowland population residing in Dion, in the Department of Pieria, in the Region of Eastern Macedonia. It consists of a mixture of locals and newcomers from the Mounts Olympus and Pindus (Vlachs and Sarakatsans), as well as of Refugees from Asia Minor and Euxinus Pontus (see Zafeiris and Kaklamani 2019). These populations have undergone significant social, economic and cultural changes over time (see Table 1). Finally, the General Sample represents an assortment of populations scattered in ecological niches of continental Greece and will be used for comparative purposes in relation to the geographically localised populations.

Data and Methods

For the purpose of the study we use data derived from the Vital Registration System of the municipalities of Metsovo and Dion and of the former communities of Organi and Kehros, which were verified and completed during fieldwork. The date of child conception to the mother was estimated as the recorded date of birth minus 260 days (Jones 1997). Estimating the date of conception in this way takes into account only registered live births; foetal loss and misscarriages are excluded from our estimates, as relevant data are unavailable. Hence, to obtain comparable results, the assumption that the rate of foetal loss is constant across seasons and across the periods under

https://doi.org/10.1017/S0021932022000396 Published online by Cambridge University Press

Table 1. Major characteristics of the understudy populations

	Population				
Characteristics	Metsovo	Dion	Organi	Kehros	General
Location	Epirus	Central Macedonia	Rhodopi/Greek Thrace	Rhodopi/Greek Thrace	Scattered
Population composition	Vlachs	Various (Locals, Vlachs, Sarakatsans, Asia Minor Refugees)	Pomaks	Pomaks	Various
Language	Vlachic (declining)/Greek	Greek/Vlachic (declining)	Of Slavic origin (Pomaks)	Of Slavic origin (Pomaks)	Greek
Religion	Greek Orthodox	Greek Orthodox	Muslims: Sunni	Muslims: Sunni, many Bektashi	Greek Orthodox
Domestic organisation	Extended families* in the past/gradual spread of the nuclear family	Extended families in the past/gradual spread of the nuclear family	Extended families in the past/slow spread of the nuclear family	Extended families in the past/slow spread of the nuclear family	Various
Ecological Area	Mountainous	Lowland	Mountainous	Mountainous	Scattered
Infrastructure	Very good	Very good	Moderate-bad	Moderate-bad	Various
Climate	Alpine Mediterranean	Mediterranean	Alpine Mediterranean	Alpine Mediterranean	Various
Ease of Access	Mountainous/provincial road network Nowadays international highway	Lowland/provincial road network. Later on: national highway	Isolated until the 1980s- Nowadays: mountainous provincial road network	Isolated until the 1980s- Nowadays: mountainous provincial road network	Various
Occupations	-Agriculture (limited) -Stockbreeding -Commerce -Forestry -Handcrafting In more recent years: -Tourism -Tertiary sector -Small scale industry	-Agriculture -Stockbreeding -Forestry -Handcrafting In more recent years: -Tertiary sector -Small scale industry	-Agriculture (limited) -Stockbreeding -Forestry -Handcrafting	-Agriculture (limited) -Stockbreeding -Forestry -Handcrafting	Various
Economic Development	Very well developed	Well developed	Poor	Poor	Various

*see later in the text

Table 2. Adjusted number of births per population and period of study

Population	Period of study			
	1951-1964	1965-1980	1981-1992	>=1993
Metsovo	745	635	351	162
Dion	2656	2187	782	476
Organi	1957	1909	1160	N/A
Kehros	879	954	556	N/A
Residuals	2176	2764	2008	1175
Total	8412	8450	4856	1814

research is implicit. Such an assumption, however, may not be fulfilled, especially concerning the different periods under investigation. It may be more realistic to assume that overtime, as socio-economic circumstances and prenatal care improve, foetal loss would decline. That could affect comparability between diferent periods, but it is unlikely to affect the estimates of the extent of seasonality within a specific period.per period of conception is unknown for these populations. In any case, the number of stillbirths is very small and this further suggests that the assumption adopted does not quantitatively affect the result. A special epidemiological study is needed for this,though even in this case any results must be questionable due to the long time gap between the time the events took place and the time the data were collected. Instead in this paper only the recorded births were taken into consideration, in the absence of any other solution in order to include foetal losses.

Overtime, socio-economic conditions, cultural factors and reproductive practices change, and tend to differentiate the observed seasonal patterns of conceptions and livebirths. Hence, the analysis refers to four discrete periods 1951-1964, 1965-1980, 1981-1992 and 1993-2002 which essentially correspond to the fertility transition in these populations (Zafeiris et al. 2015; Zafeiris and Kaklamani 2019; Zafeiris 2020). The fertility transition in all of these populations led to the decrease of the total fertility rate, with various rhythms. Specifically, fertility was very high in the Pomaks until 1964, with more than 4 children per woman (Zafeiris 2020). In Metsovo, where fertility transition started earlier, period TFRs fluctuated between 2.8 and 2.6 children per woman in the period 1951-1964 (Zafeiris et al 2015). In Dion, fertility remained high for the cohorts reproducing during this era (Zafeiris and Kaklamani 2019). After 1964 and until 1980, fertility declined rapidly in all the populations studied, and a new demographic regime of low fertility appeared in the 1980s. As a result, women give birth to fewer children over time, a fact that is portrayed in table 2 of this paper.

Due to the heterogeneity of the five populations with respect to religion, socio-economic milieu, employment activities and certain traditions, the statistical analysis considers them separately. Their characteristics are presented in detail in Table 1 (Metsovo, Dion, Organi, Kehros, General Sample). The analysis is carried out as follows.

The micro-statistical information on date of birth and the consequently estimated conception date was converted to aggregate data, referring to numbers of conceptions by month and year of observation. However, one must take into consideration the unequal length of months in a year, which obviously distorts the real seasonality patterns. In order to confront this problem the observed aggregated monthly data were adjusted to numbers of conceptions of months of equal number of days (30 days). The statistical analysis was performed using the adjusted numbers of conceptions by month and period of study shownin Table 2.

We employ the following procedure to portray seasonal variations of conceptions. Using the adjusted monthly numbers of conceptions, we construct seasonal indices applying a variant ratio

https://doi.org/10.1017/S0021932022000396 Published online by Cambridge University Press

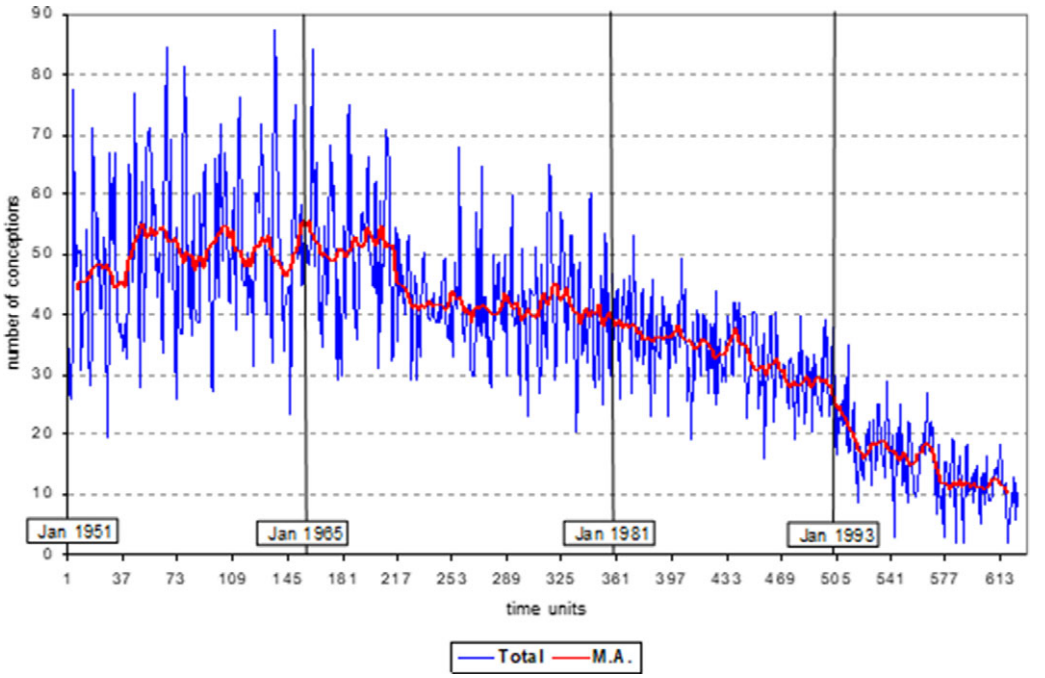

Figure 1. Observed monthly number of conceptions (OBS) and 12-month moving averages (M.A.): Total (all samples) 1951 - 2002.

to moving averages method. We calculate centered moving averages which are much smoother than the original data, so that they reflect a clearer picture of the long term trend of conceptions (Kvanli et al. 1996). The ratios of the observed data to the centered moving averages reveal, in relative terms, the seasonality of the phenomenon. These ratios are considered as dependent variable. Subsequently, we express each month in terms of binary dummy variables, and we introduce these dummy variables in the models as regressors. Finally, we estimate multiple linear regressions without a constant term (Brooks 2008); the estimated regression coefficients correspond to twelve seasonal indices, showing the percentage excess or deficit of monthly conceptions for a specified period. Finally, we also calculat the coefficient of variation as an overall measure of the seasonal fluctuations. The coefficient of variation (CV) is calculated as the ratio of the standard deviation to the mean, indicating the extent of variability in relation to the mean of the population (see Kirkwood, 1979).

Results

Conceptions show intense seasonal fluctuations and a long-term downward trend over time. Figures 1-6 present the observed number of conceptions by month as well as the 12-month moving average for each population separately and for the whole sample, for the overall period of the study. The total number of conceptions (Figure 1) follows a downward trend, which appeared initially in 1968 and was established more clearly in 1981; seasonality is evident, but the range of seasonal variation gets smaller over time. Several differences, however, are observed across samples and periods. Note that the number of births for the period since 1993 does not include the Pomaks of Organi and Kehros, due to a lack of relevant data. Therefore, total numbers of births for this period (Figure 1) are not comparable to the other periods included in the analysis.

https://doi.org/10.1017/S0021932022000396 Published online by Cambridge University Press

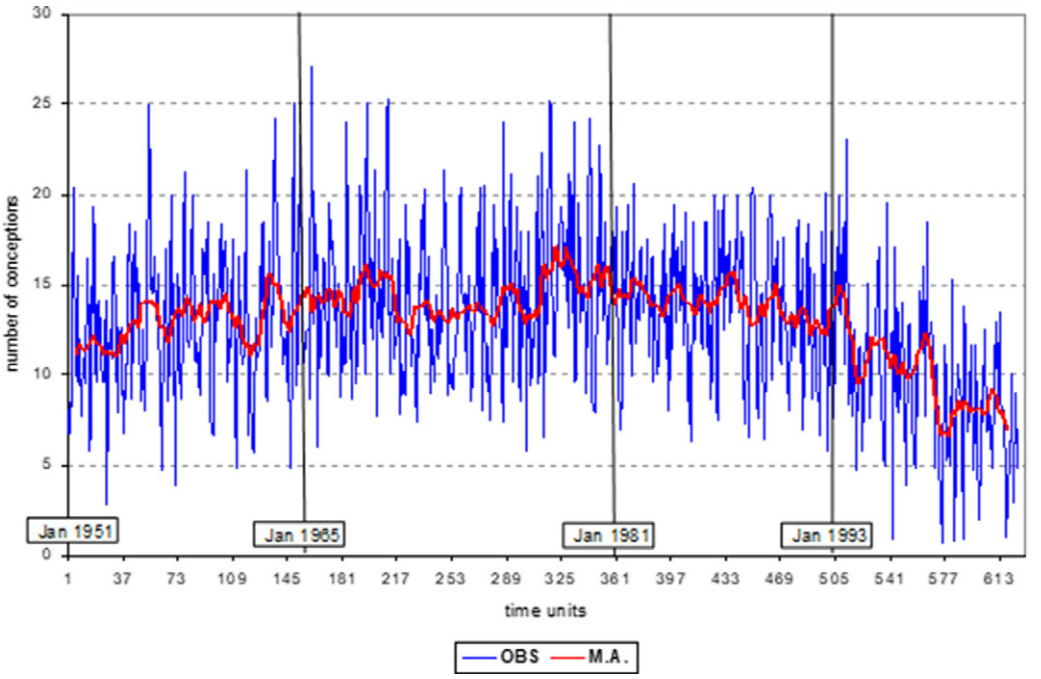

Figure 2. Observed monthly number of conceptions (OBS) and 12-month moving averages (M.A.): General Sample 1951 - 2002.

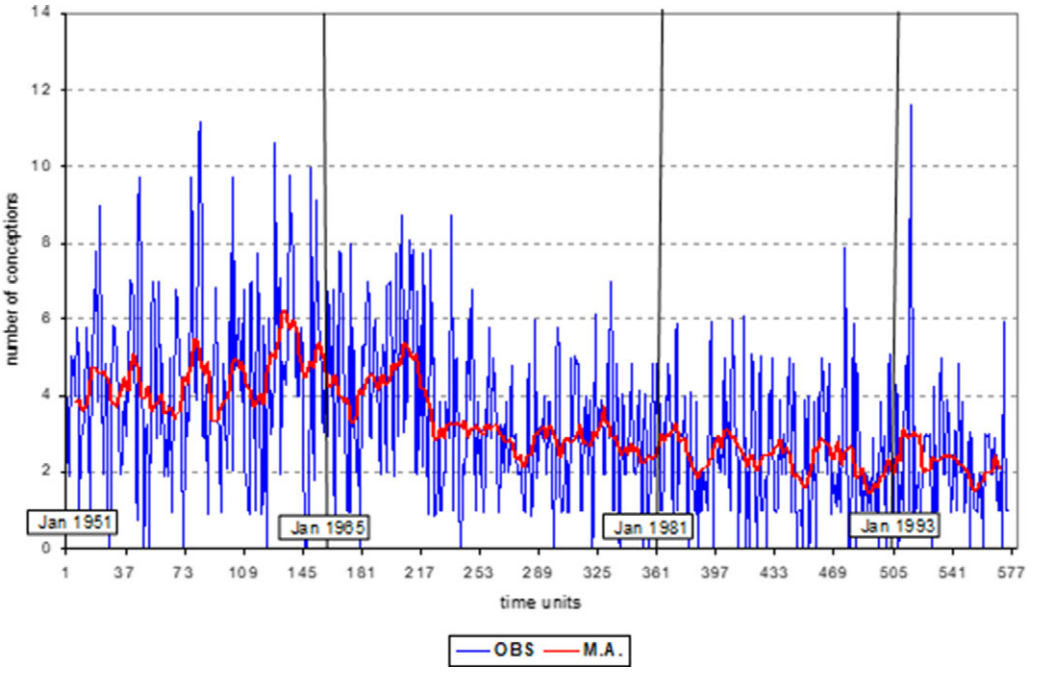

Figure 3. Observed monthly number of conceptions (OBS) and 12-month moving averages (M.A.): Metsovo 1951 - 1998.

https://doi.org/10.1017/S0021932022000396 Published online by Cambridge University Press

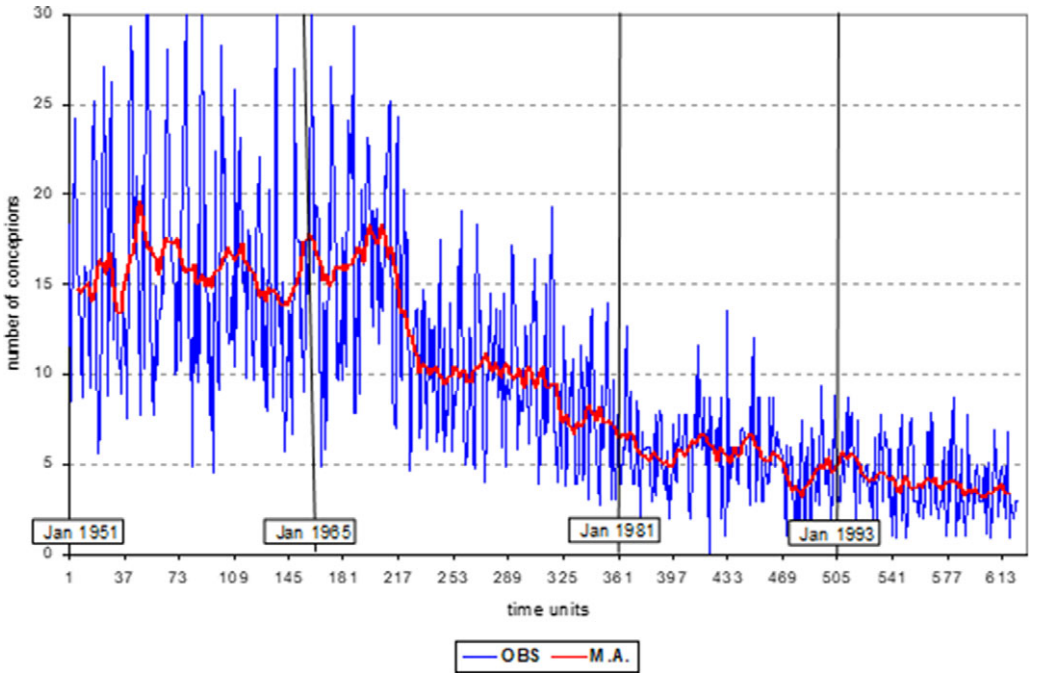

Figure 4. Observed monthly number of conceptions (OBS) and 12-month moving averages (M.A.): Dion 1951 – 2002.

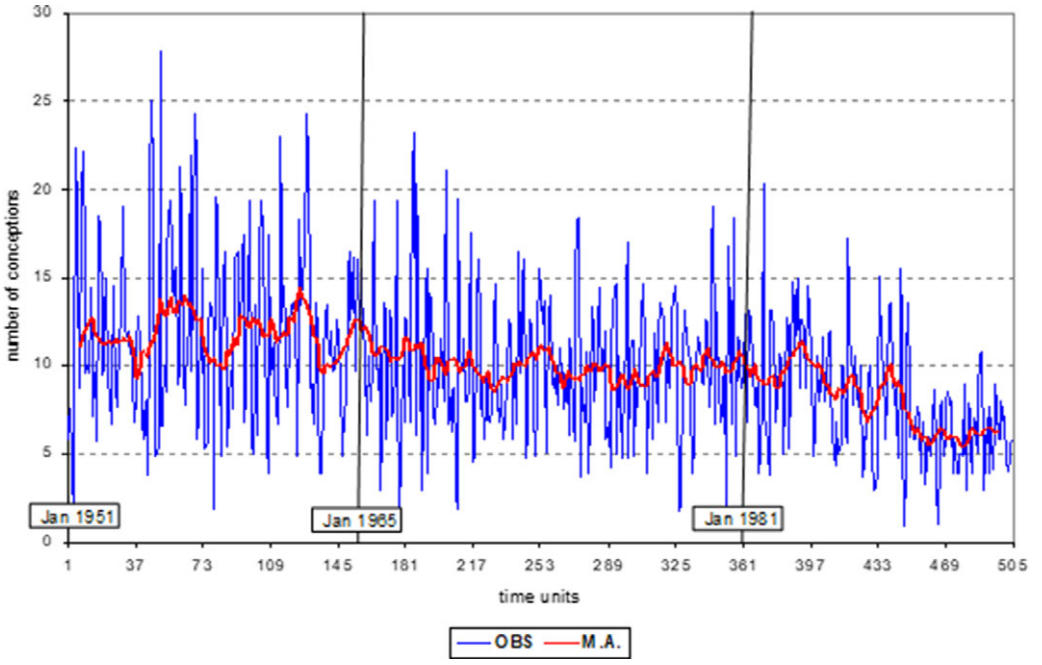

Figure 5. Observed monthly number of conceptions (OBS) and 12-month moving averages (M.A.): Organi 1951 - 1992.

https://doi.org/10.1017/S0021932022000396 Published online by Cambridge University Press

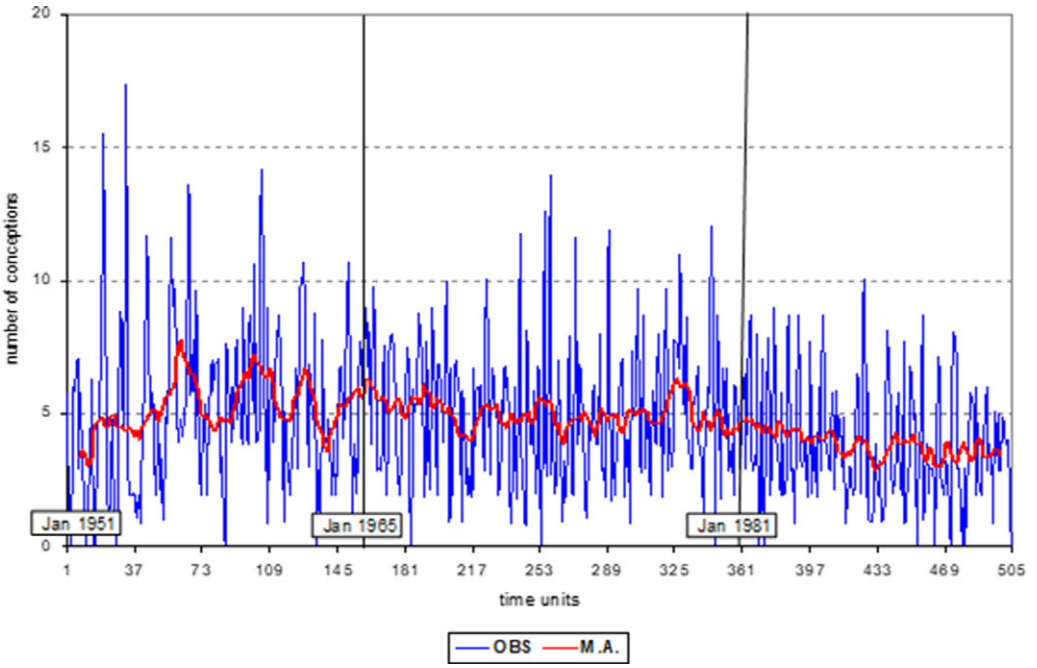

Figure 6. Observed monthly number of conceptions (OBS) and 12-month moving averages (M.A.): Kehros 1951 - 1992.

Analysis by period

During the first period (1951-1964), individual reproductive behaviour presents many similarities across populations, as the number of conceptions tends to be higher in late spring and some summer months (Figure 7; see also Table 3). Nevertheless, there is still high diversity.

First, a Christmas or a New Year's Eve effect is not easily detected. Conceptions in January remain either very low, like in Kehros, or close but below the value of 100, which denotes an equal distribution of conceptions between the months of a year (dotted black line in Figure 7). The only exception is observed for Organi in January, but people there are Muslims, and those days they did not celebrate the arrival of the New Year, as fieldwork evidence suggests. Note that in the previous month, i.e., December, the number of conceptions was very low in all populations. Therefore, at least for the Christian populations of the analysis, the advent of Christmas and New Year holidays may have slightly increased sexual activity and, consequently, conceptions in January compared to December.

In the following months, conceptions decrease in all populations. For the Christians, this could be an effect of the fast of Lent, during which the more religious population groups avoided any sexual activity. However, this is also observed among Muslims. The conceptions remained low since late autumn and throughout the winter, irrespective of religion, culture, domestic economy, social status or geographic location; evidence for limited sexual activities during the colder months of a year because of hormonal or other physiological reasons are discussed in the introductory section of this paper (this limitation besides humans has been found in other biological species; see Retana-Marquez et al., 2003; Demir et al., 2016).

Thus, while religious obligations seem to be essential initially, the observed similarity with the practices of the Muslim populations denotes the multivariate nature of the phenomenon and weakens but does not completely negate the effect of religious restrictions on it. As a matter of fact, after the Greek Orthodox Easter, usually in April, the number of conceptions increases

https://doi.org/10.1017/S0021932022000396 Published online by Cambridge University Press

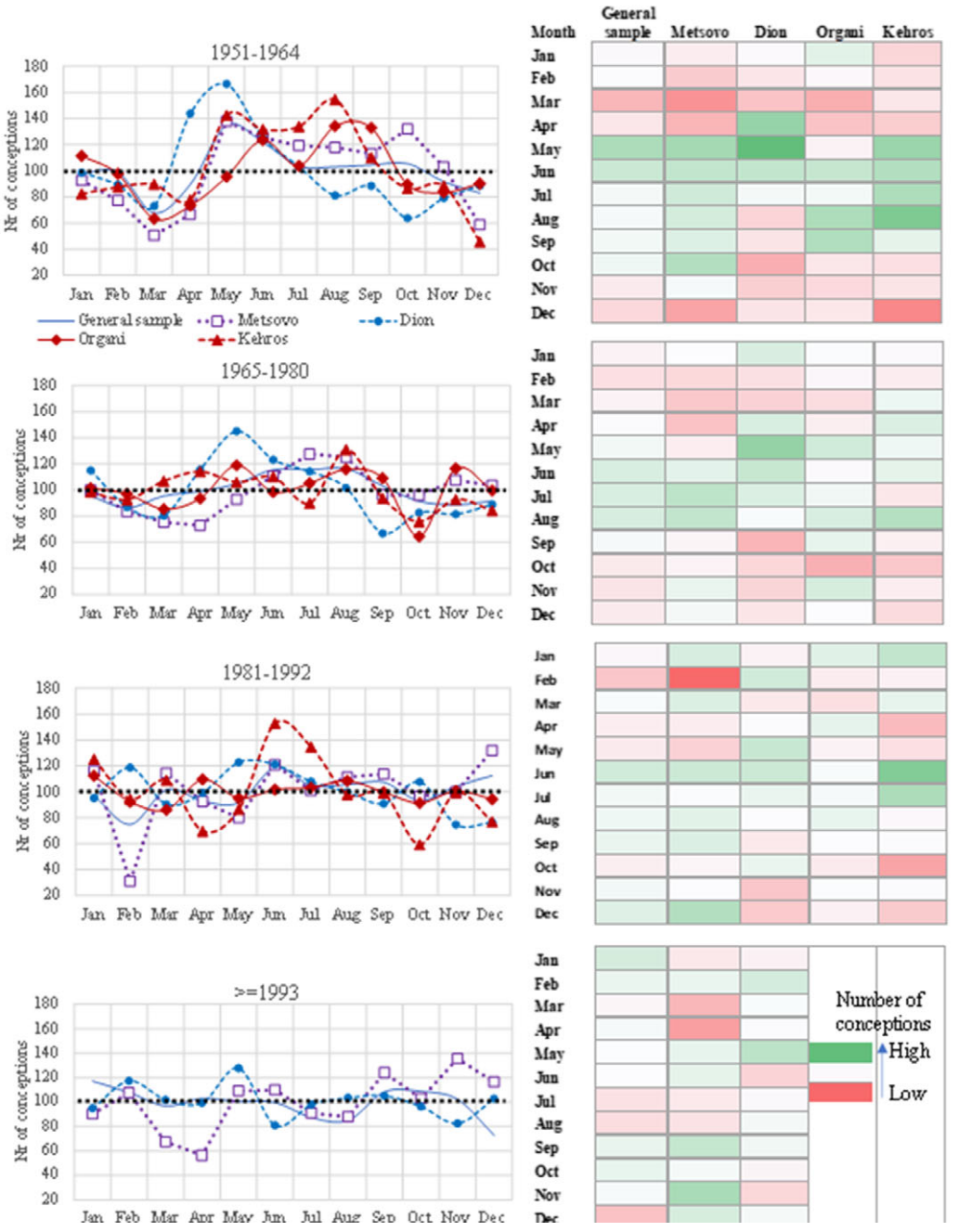

Figure 7. The seasonality of conceptions by population.

rapidly in Dion, this being direct evidence of the religious festivities on sexuality. People of the general samplefollow with a one month delay, as do the other populations. However, the early increase in child conceptions in Dion highlights the agricultural orientation of the region where, as a lowland area, the growing season begins earlier compared to the mountainous areas of Greece. The conceptions reach a peak there during May and, afterwards, they decrease rapidly until almost

https://doi.org/10.1017/S0021932022000396 Published online by Cambridge University Press

Table 3. Coefficient of determination R^2 of the regressions

Population	Period			
	1951-1964	1965-1980	1981-1992	>=1993
Metsovo	0.96	0.90	0.87	0.88
Dion	0.95	0.92	0.87	0.83
Organi	0.91	0.89	0.90	
Kehros	0.92	0.91	0.92	
Residuals	0.94	0.93	0.95	0.89

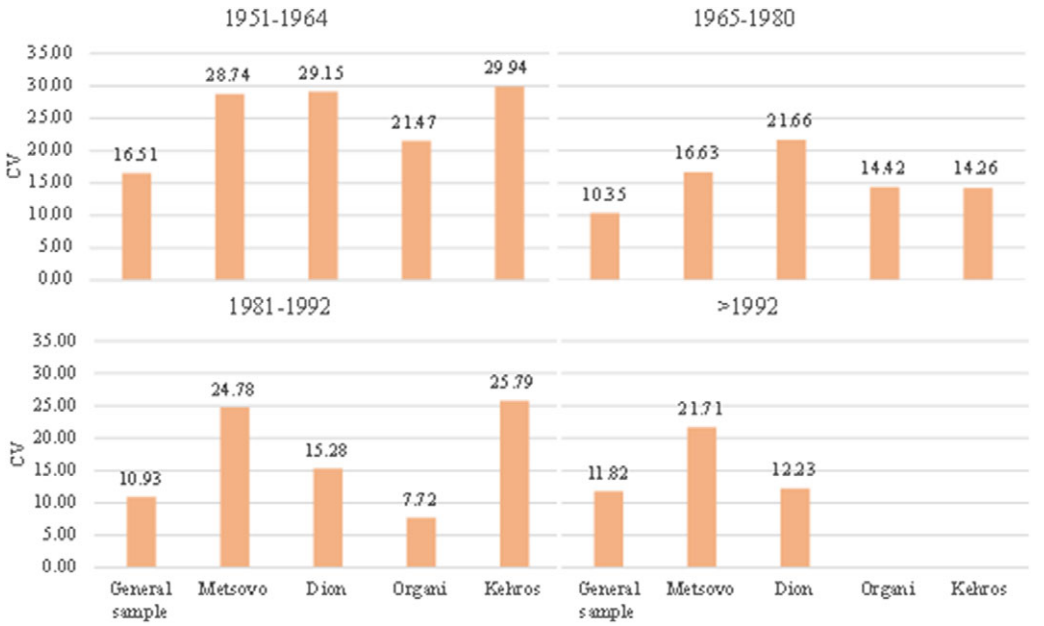

Figure 8. Coefficient of variation (ratio of standard deviation to the mean %).

October. Similarly, in the General sample whose members are scattered in various regions of Northern Greece mainly, the delayed increase of conceptions in May is accompanied by a decrease towards July and a relative stability until October. In the mountainous populations, conceptions are high in late spring. After a summer plateau, a second peak is observed in August-September in Rhodopi and in October in Metsovo.

The coefficient of variation within each population and period may indicate the observed heterogeneity among the populations (Figure 8). In the first period (1951-1964), the seasonality is intense in all populations but less so in the general sample. In the following period (1965-1984), the seasonality of conceptions declines considerably except maybe for Dion and, to a lesser degree, for Metsovo. The situation is somewhat similar to the previous period (1951-1964); conceptions are relatively high during the late spring/summer months (May to August).

In the following period (1981-1992), seasonal fluctuations become milder, and the pattern of seasonality becomes less clear in most populations (Figures 7 & 8). However, June is still the month exhibiting high seasonal indices of conceptions for all populations; the broadest range

https://doi.org/10.1017/S0021932022000396 Published online by Cambridge University Press

in seasonal indices is observed in Metsovo and Kehros. On the other hand, February and October show a relative drop in conceptions in all populations except for the region of Dion.

In the last period (1993 onwards), there were insufficient or no data on conceptions for Organi and Kehros; only for the General sample and the populations of Metsovo and Dion it was possible to estimate seasonal indices. In Metsovo, which exhibits the largest range of seasonal fluctuations, an elevated number of conceptions is observed in September and during winter (November and December). In the General sample, a high number of conceptions is observed during the autumn months of September and October, while in Dion, only in May a modest rise of conceptions can be observed.

Analysis across periods

Examining the seasonal indices over time, we see several differentiations both between populations and between periods. In general, however, it appears that there is a tendency for an increase in the intensity of conceptions among the mountainous populations during the late spring/summer season, irrespective of people's religion.

Looking at the monthly data on conceptions, it is noticeable that the range of seasonal fluctuations over time tend to decrease in all samples (Figures 7 and 8). The last period (1993 onwards) is perhaps an exception for the General Sample and the region of Metsovo, but this may be a feature of this period or may be due to the realisation of a smaller number of conceptions compared to previous periods. In fact, the small number of births during that period may have affected the observed seasonality patterns, but to an unknown extent.

The estimated seasonal indices, which portray the relative excess or deficit of the conceptions by month, also depict similar patterns of variation of the events across different periods.

Discussion and conclusions

The present study uses vital registration data regarding five distinct population subgroups of mainland Greece (residing in Metsovo, Dion, Organi, Kehros, and a General Sample) to explore the seasonality of conceptions for the period 1951-2002. These populations exhibit different characteristics concerning the area of residence (Metsovo, Organi and Kehros are mountainous areas whereas Dion is situated in a plain), religion, socio-economic status, employment activities and certain traditions. The analysis aims to add evidence on this sparcely researched topic for Greece.

The findings indicate that there is seasonality of conceptions in all populations under study, more prominent in the period 1951-64. Seasonality decreases over time, especially from 1981 onwards, though at a different pace for the different populations. The extent of seasonality differentiates across populations; it is less pronounced in the general sample throughout the whole period under investigation.

Conceptions are at low levels during winter and early spring in all populations. Among mountainous populations, there is a tendency of an increased number of conceptions during late spring and early summer, irrespectively of religion or socio-economic status. By contrast, in lowland areas (Dion) the increase in conceptions is observed slightly earlier (in April), reflecting both religious practices (greater sexual activity following Lent) as well as an earlier onset of agricultural activities in plains compared to mountainous areas. Qualitative fieldwork evidence suggests that the older women of the christian populations considered sexual relations during Lent a supreme sin and avoided them. Of course, even in the strictest environments, people can often act and go beyond the rules. a fact which permits several conceptions to occur during that time. As religiosity declined over time, younger generations were not that keen on following cultural and religious norms. In Muslim populations, any effort to identify religious effects on seasonality is dubious because religious holidays have a mobile character following the Gregorian calendar. For example, the Ramadan festivities, a period of daily fasting, may occur in different months during subsequent years.

https://doi.org/10.1017/S0021932022000396 Published online by Cambridge University Press

Hence, it seems that people with different religions and ecological landscapes have significant similarities in their sexual and reproductive activities. Therefore, the Greek Orthodox Easter could partially contribute as an inhibiting factor of procreation for the Christians, but other factors seem equally essential, indicating the multivariate pattern of human existence. The case of Metsovo is indicative of this complexity. While in the first period of study Metsovo follows Dion, though with a significant time lag in the Lent period, in the second period under study (1965-1980), conceptions increase in Metsovo from April to May, but remain below average. A brief discussion of such factors follows.

The first such factor reflects the agricultural production cycles, which differ between the mountains and the plains: the intense agricultural work starts earlier in the lowlands. However, is this a matter of time or climate, as found for several populations worldwide (see introduction)? During those times, most people in Dion were growers of tobacco or cereals and several vegetables, while a few were cattle breeders, having abandoned their previous livestock and mountainous life (Zafeiris and Kaklami, 2019). By contrast, Metsovo retained its character as a Vlachic Metropolis (Zafeiris et al., 2015). A variety of occupations characterised its population. Besides the limited cultivations, people were still stockbreeders, woodcarvers, conductors, and merchants. Pomaks, being in the worst economic situation compared with the others because of their geographical and cultural isolation, were small farmers, stockbreeders and loggers. They were trying to survive in an adverse environment without actively participating in the market economy(Zafeiris, 2020; Zafeiris and Koukli, 2022). Besides this heterogeneity, all the mountainous populations have several analogies in their procreational activities. Thus, climate and several other ecological factors (like the type of ecological habitat) are mainly responsible for the monthly distribution of conceptions irrespectively of their socio-economic characteristics.

As ethnographic evidence collected during fieldwork suggests, another factor must be considered: the mechanization of production first in the Christian populations and later in the Muslim ones. However, the lack of solid evidence does not allow an estimation of its effects on seasonality. Additionally, the harsh winters in the mountains may have affected seasonality patterns. The working cycles differ significantly between the study's mountainous and plain populations. A typical example is that the mountain goats and sheep are born much later each year than in the lowlands. Thus, as ethnographic evidence suggests, the working cycles are intensified later in the mountains. However, the workload in the fields permits the couple to find time and space for sexual intercourse, freed from the confines of his household. Many women expressed their despair at the lack of freedom and the total embrace of their family during the winter, when all members of a household lived together within the extended family.

After all, the extended family is the typical family formation in all populations, except perhaps for the General sample. In this system, the couple, their male progenies with their wives and grandchildren, often share the same room under the same roof, which is divided into individual spaces usually using rugs. If the family's economic situation allows, new adjusted rooms can be built, in which the two spouses live together with their children, but separately from the other couples of the extended family, yet still under a common or neighbouring roof (see Zafeiris et al., 2015; Zafeiris and Kaklamani, 2019; Zafeiris, 2020; Zafeiris and Koukli, 2022). Obviously, in this limited space, considering that the bad weather inhibits life outside home, the possibilities for sexual relations are significantly limited. The couple feels freer when working in the countryside, and thus its sexual activity increases.

Moreover, fieldwork evidence suggests that couples need to plan for the "arrival" of a new child. This is more beneficial when there is no demanding farm work as, on the one hand, the child will enjoy his mother's attention to a greater extent, and, on the other hand, it will have grown to some extent when his mother works in the fields a few months after its birth. Thus, people recognized this necessity, and they acted accordingly. Additionally, a mother should not be in advanced pregnancy when she needs to work in the fields. After all, family planning seems necessary in these populations, regardless if it is socially accepted or recognized.

https://doi.org/10.1017/S0021932022000396 Published online by Cambridge University Press

One could suggest that these populations should have been in a natural fertility state where family planning was absent. However, data not cited here revealed that though a couple had their first child nine months after marriage or soon thereafter, the couple could regulate the length of their reproductive life, stopping it when the desired number of progenies was achieved while also practising birth spacing (Zafeiris et al., 2015; Zafeiris and Kaklamani, 2019; Zafeiris, 2020; Zafeiris and Koukli, 2022). Fieldwork evidence suggests that coitus interruptus and abstinence from sexual intercourse were widespread methods. Therefore, the timing of a birth depended on various physiological, ecological, economic and cultural characteristics, not to mention the estimated workload by the time of the birth.

Nevertheless, in more recent times, as economic development and modernization took hold, traditional patterns became gradually less important. The dependence of these populations on agricultural and livestock activities for their survival decreased, as did their cultural isolation and traditionalism. Consequently, seasonality of conceptions declined substantially, as the relevant circumstances changed.

References

Bobak, M.& Gjonca, A. (2001). The seasonality of live birth is strongly influenced by sociodemographic factors. *Human Reproduction* **16**(7), 1512–1517.

Brooks, C. (2008). *Introductory econometrics for finance*. 2nd edition. Cambridge: Cambridge University Press.

Cummings, D. (2007). Additional confirmation for the effect of environmental light intensity on the seasonality of human conceptions. *Journal of Biosocial Science* **39**(3), 383–396. doi: 10.1017/S0021932006001568

Cornelisse, V. J., Chow, E. P. F., Chen, M. Y., Bradshaw, C. S., & Fairley, C. K. (2016). Summer heat: a cross-sectional analysis of seasonal differences in sexual behaviour and sexually transmissible diseases in Melbourne, Australia. *Sexually Transmitted Infections* **92**, 286–291. doi: 10.1136/sextrans-2015-052225

Cypryjański, J. (2019). Changes in seasonality of births in Poland in the years 1900–2009. *Demographic Research* **40** (49), 1441–1454. doi: 10.4054/DemRes.2019.40.49

Darrow, L., Strickland, M. J., Klein, M. Waller, L., Flanders, W. D., Adolfo, C. Michele, M. & Paige E. T. (2009). Seasonality of Birth and Implications for Temporal Studies of Preterm Birth. *Epidemiology* **20**(5), 699–706. doi: 10.1097/EDE.0b013e3181a66e96

David A. L. & Miron, A. J. (1991). Seasonality of births in human populations. *Social Biology*, **38**(1-2), 51–78. doi: 10.1080/19485565.1991.9988772

Dahlberg, J. & Andersson, G. (2018). Changing seasonal variation in births by sociodemographic factors: a population-based register study. *Human Reproduction Open*, **2018**(4), 1–8. doi: 10.1093/hropen/hoy015

Demir, A., Uslu, M., & Arslan, O. E. (2016). The effect of seasonal variation on sexual behaviors in males and its correlation with hormone levels: a prospective clinical trial. *Central European Journal of Urology* **69**, 285–289.

Didikoglu, A, Canal, M. M., Pendleton, N. & Payton, A. (2020). Seasonality and season of birth effect in the UK Biobank cohort. *American Journal of Human Biology* **32**, e23417. doi: 10.1002/ajhb.23417

Doblhammer-Reiter, G., Rodgers, J.L. & Rau, R. (2000). Seasonality of Birth in Nineteenth and Twentieth-Century Austria. *Social Biology* **47**(3/4), 201–217.

Gavalas, V. S. (2009). Seasonality of vital events in an Aegean island: a story of fasts feasts and fieldwork. *Statistical Review* **5**(1-2), 3–25.

Grech, V., Savona-Ventura, C., Agius-Muscat, H., & Janulova, L. (2003). Seasonality of births is associated with seasonality of marriages in malta. *Journal of Biosocial Science* **35**(1), 95–105. doi: 10.1017/S0021932003000956

Greksa, L. (2004). Birth seasonality in the old order Amish. *Journal of Biosocial Science* **36**(3), 299–315. doi: 10.1017/S0021932003006254

Hennink, M., Cooper, P. & Diamond, I. (2000). Seasonal work and sexual behaviour. *Journal of Sex Research* **37**(2), 175–183. doi: 10.1080/00224490009552035

Herteliu, C., Ileanu, B.V., Ausloos, M. & Rotundo, G. (2015). Effect of religious rules on time of conception in Romania from 1905 to 2001. *Human Reproduction* **30**(9), 2202–2214. doi: 10.1093/humrep/dev129

Jones, E. R. (1997). *Human Reproductive Biology*. Second Edition. London: Academic Press.

Kirkwood, T. B. L. (1979). Geometric means and measures of dispersion. *Biometrics* **35** (4), 908–9.

Krassas, G. E, Tziomalos, K., Pontikides, N., Lewy, H. & Laron, Z. (2007). Seasonality of month of birth of patients with Graves' and Hashimoto's diseases differ from that in the general population. *European Journal of Endocrinology* **156**(6), 631–636. doi: 10.1530/EJE-07-0015. PMID: .

Kvanli, A.H., Guynes, C.S. and Pavur. J, (1996). *Introduction to Business Statistics, A Computed Integrated, Data Analysis Approach*. Fourth Edition, Chapter Sixteen, New York: West Publishing Company.

Lam, D. A. & Miron J. A. (1991). Seasonality of birthsin human populations. *Social Biology* **38**(1-2), 51–78.

Lam, D. A. & Miron, J. A. (1994). Global patterns of seasonal variation in human fertility. *Annals of the New York Academy of sciencies* **709**, 9–28. doi: 10.1111/j.1749-6632.1994.tb30385.x. PMID: .

Lummaa, V, Lemmeyinen, R., Haukioja, E. & Pikkola, M. (1998). Seasonality of births in Homo sapiens in pre-industrial Finland: maximisation of offspring survivorship? *Journal of Evolutionary Biology* **11**, 147–157.

Martinez-Bakker, M., Bakker, K. M., King, A. A., Rohani, P. (2014) Human birth seasonality: latitudinal gradient and interplay with childhood disease dynamics. *Proceedings the Royal Society B: Biological Sciencies* **281**, 20132438. doi: 10.1098/rspb.2013.2438

Quételet A. (1826). Mémoire sur les lois des naissances et de la mortalité à Bruxelles. *Mémoires de l'académie Royale des Sciences et des Belles Lettres de Bruxelles, t.* **III**, 495–512.

Retana-Marquez, S., Bonilla-Jaime, H., Vazquez-Palacios, G., Martinez-Garcia, R. & Velazquez-Moctezuma, J. (2003). Changes in masculine sexual behavior, corticosterone and testosterone in response to acute and chronic stress in male rats. *Hormones and Behavior* **44**, 327–337.

Régnier-Loilier, A. Trans. by Divinagracia, E (2010). Évolution de la saisonnalité des naissances en France de 1975 à nos jours. *Population* **65**, 145–185. https://www.cairn-int.info/journal-population-2010-1-page-145.htm

Roenneberg, T. (2004). The Decline in Human Seasonality. *Journal of Biological Rhythms* **19**(3), 193–195. doi: 10.1177/0748730404264863

Ruiu, G. & Breschi, M. (2019). Intensity of Agricultural Workload and the Seasonality of Births in Italy. *European Journal of Population* **36**(1), 141–169. doi: 10.1007/s10680-019-09524-1

Polašek, O., Kolčić, I., Vorko-Jović, A., Kern, J. & Rudan, I. (2005). Seasonality of Births in Croatia. *Collegium antropologicum* **29**(1), 249–255. https://hrcak.srce.hr/5101

Simó-Noguera, C. X., Lledó, J., Pavía, J. M. (2020). Lent impact on the seasonality of conceptions during the twentieth century in Spain. *European Journal of Population* **36**(5), 875–893. doi: 10.1007/s10680-020-09555-z

Singh, B, S., Gupta, K. & Roy, T. K. (2020). Seasonality in conception: comparison of pattern in Uttar Pradesh and Kerala. *International Journal of Recent Scientific Research* **11**(07 C), 39281–39283. doi: 10.24327/IJRSR

Surbey, M. K., De Catanzaro, D. & Smith, M. S. (1986). Seasonality of conception in hutterite colonies of Europe (1758-1881) and North America (1858-1964). *Journal of Biosocial Science* **18**(3), 337–345.

Wellings, K., Mcdowall, W., Catchpole, M. & Goorch, J. (1999). Seasonal variations in sexual activitu and their implications for sexual health promotion. *Journal of the Royal Society of Medicine* **92**, 60–64.

Wesselink, A. K., Wise, L. A., Hatch, E. E., Mikkelsen, E. M., Sørensen, H. T., Riis, A. H., McKinnon, C. J. & Rothman, K. J. (2020). Seasonal patterns in fecundability in North America and Denmark: a preconception cohort study. *Human Reproduction* **35**(3), 565–572. doi: 10.1093/humrep/dez265

Wilson, T., McDonald, P. & Temple, J. (2020). The geographical patterns of birth seasonality in Australia. *Demographic Research* **43**(40), 1185–1198. doi: 10.4054/DemRes.2020.43.40

Wood, I. B., Varela, P. L., Bollen, J., Rocha, L. M. & Gonçalves-Sá, J. (2017). Human Sexual Cycles are Driven by Culture and Match Collective Moods. *Scientific Reports* **7**, 17973. doi: 10.1038/s41598-017-18262-5

Yang, Y. (2021). Analysing the seasonality of births in mainland China. *Journal of Biosocial Science* **53**(2), 233–246. doi: 10.1017/S0021932020000164

Zafeiris, K. N. (2012). The seasonality of births and the effects of the ecological conditions and populations' cultural, economic, and social characteristics. In: Gospodini, A., Kotzamanis, B. et al. (eds.). Proceedings of the 3rd Panhellenic Conference on Urban Planning, Spatial Planning and Regional Development. Polytechnic School of the University of Thessaly. Volos 27-30 Sep. 2012. Volos: University Publications of Thessaly. pp. 1018-1026. [In Greek]

Zafeiris, K. N., Hatzisavva, K. & Xirotiris, N. I. (2015). Fertility in the Vlachic population of Greece: a demo-anthropological approach of Metsovo, 1930-1999 with the application of a genealogy-based method of analysis. *Genus* (**LXXI**), **1**: 61–78.

Zafeiris, K. N. & Kaklamani, S. (2019). Completed fertility during the 20th century: an example from 6 settlements of Northern Greece. *Journal of Biosocial Science*, **51** (1), 118–137. doi: 10.1017/S002-1932018000019

Zafeiris, K. N. (2020). Pomaks in Mountainous Rhodopi: A Demographic Approach. In: Varvounis, M. G. & Mpartsiokas, A. & Maha-Mpizoumi, N. The Pomaks of Thrace: Multidisciplinary and Interdisciplinary Approaches, Thessaloniki: K. & M. Stamoulis.

Zafeiris, K. N. & Koukli, M. (2022). Some Observations on the Demographic Variables of Marriage System in Greek Thrace: Evidence from Several Anthropological Populations. *Genealogy* **6**(1), 12. doi: 10.3390/genealogy60100-12

Cite this article: Zafeiris KN, Tsimbos C, Verropoulou G, and Hatzisavva K (2023). Studying the seasonality of conceptions among five distinct population subgroups in mainland Greece: a story of similarities and variability. *Journal of Biosocial Science* **55**, 893–907. https://doi.org/10.1017/S0021932022000396