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Comparison of the Effects of Mediterranean Temperate and Cold Mountain Climates on Human Fertility

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ABSTRACT

Background: Owing to the emergence of some challenges in the demographic structure of many countries and possible decrease in young human workforce in the future decades, the reduction in the fertility rate has become a major public concern. This study aimed to investigate the effects of climatic factors on fertility. **Aim:** In this correlational study conducted during 2005–2009, the relationship between climatic factors (monthly average temperature, air pressure, rainfall, and humidity) and monthly fertility in women living in areas with two different climates was investigated. **Methods:** The study regions included two cities of Iran: Behshahr and Hamedan having temperate Mediterranean climate and cold mountain climate, respectively. The means and standard deviations of the investigated variables were computed and reported. Furthermore, Pearson correlation coefficients and linear regression were also employed. **Results:** The findings indicated that monthly fertility in women living in temperate Mediterranean climate was related to temperature ($r = -0.340$, $p = 0.008$), air pressure ($r = -0.502$, $p = 0.002$), and rainfall ($r = 0.319$, $p = 0.013$), whereas this relationship was not found in women living in cold mountain climate. Furthermore, fecundity peak was observed during autumn in both the climates. **Conclusions:** Considering the influences of climatic factors on fertility, it would be better if physicians pay attention to other aspects of human fertility than the clinical conditions during client evaluation.

Key words: Climatic Factors, Fertility, Iran.

1. INTRODUCTION

In many countries, fertility rate has decreased, and it is predicted that the world population will decline from 11.5 to 9.5 billion by the year 2050 (1, 2). Accordingly, the total fertility rate is anticipated to reach from 5 in 1950 to 2.2 by 2050 (3, 4). Meanwhile, in some African countries, the mean fertility rate is still 5.1, whereas that in some European countries is ≤ 1.2 (1, 2). The reduction in the fertility rate is believed to occur as a result of factors such as population control policy owing to post World War II population increase (5); social changes, including women's education and employment; poor government policies in the area of social welfare; lack of supporting system for working pregnant women (6, 7); and delayed marriage age and pregnancy (8-10). Furthermore, in some coastal regions, the population increase has created shortage of some food resources, thus affecting fertility rate (11).

Recent studies have suggested that besides the above-mentioned socioeconomic factors, some environmental factors such as climatic factors influence the fertility rate (11, 12). Along these lines, some studies have exhibited an inverse relation-

ship between temperature and human fertility in some parts of the world. The results of the United Nation's research in 19 industrialized countries demonstrated fertility rate reduction corresponding to increased temperature in these countries (12). Furthermore, some researchers have claimed that a temperature increase of 0.5–1°C since the 20th century has resulted in some negative effects on vulnerable population such as infants, children, and pregnant mothers (13, 14, 15, 16). In addition, in developing countries where dependency on natural resources is high, the phenomenon of global warming has been noted to threaten people's food security and decrease access to sources of calories, thus having some negative effects on human fertility (17, 18). Some researchers have also reported that photoperiod of different season influences couples' fertility rate (19). Nevertheless, to the best of our knowledge, most of the previous studies have often been conducted in temperate climate to investigate the relationship between climatic factors and fertility, and there are limited studies comparing the effects of various climates on fertility. Because Iran is a large country with different climates (20), we aimed to assess the effects of some climatic factors on

fertility in two climates: temperate Mediterranean climate and cold mountain climate.

2. MATERIALS AND METHODS

In this correlational study conducted by using a documentary method, monthly fertility was investigated in two cities, Behshahr and Hamedan, with two diverse climates for a 5-year period from 2005 to 2009. The former city, situated across the Caspian Sea, has a temperate Mediterranean climate, whereas the latter city has a cold mountain climate.

The required quantitative data were collected from the medical records of State hospital and from meteorology station located in each city. The first part of the data was derived from the hospital profiles of 14,485 (Behshahr) and 36,580 (Hamedan) women who delivered their babies (either normal vaginal delivery or cesarean section) in the State hospital of each city during the study period. Monthly fertility was determined on the basis of the corresponding dates 9 months prior to the delivery dates. The second part of the data included information on climatic factors, such as monthly average temperature, air pressure, rainfall, and humidity, obtained from the meteorology stations of both the cities during the study period.

Ethical issues (Including plagiarism, Informed Consent, misconduct, data fabrication and/or falsification, double publication and/or submission, redundancy, etc.) have been completely observed by the authors. Also, the study was conducted by presenting governmental permits and observing obligations in terms of not publishing and presenting other statistics and information related to the state hospitals, except the statistics related to the present study.

All the data were analyzed by using SPSS software, version 17, and the relationship between the data was analyzed by Pearson correlation and regression test, with p-values of ≤ 0.05 indicating significance.

3. RESULTS

The results revealed that the mean monthly fertility was 241.41 ± 33.31 and 609.66 ± 70.59 for women living in Behshahr and Hamedan, respectively. Furthermore, the monthly average of all the climatic factors was higher in the temperate Mediterranean climate than that in the cold mountain climate. Table 1 shows the monthly average of the climatic factors determined in the two different climates.

Significant relationships were noted between climatic factors such as temperature, rainfall, and air pressure and monthly fertility in temperate Mediterranean climate, although such relationships were not observed in cold mountain climate. In contrast, no correlation was found between humidity and monthly fertility in both the examined climates. Table 2 presents the relationships between the climatic factors and monthly fertility in the two different climates. As shown in the table, an inverse

Climatic factors	Temperate Mediterranean climate	Cold mountain climate
Temperature	17.34 $\pm$ 7.36 (Centigrade)	12.17 $\pm$ 9.26 (Centigrade)
Air pressure	1017.50 $\pm$ 4.68 (Milibar)	826.07 $\pm$ 2.48 (Milibar)
Rainfall	54.85 $\pm$ 49.84 (Millimeter)	25.40 $\pm$ 28.68 (Millimeter)
Humidity	80.01 $\pm$ 3.91 (Percent)	51.63 $\pm$ 17.74 (Percent)

Table 1. Mean and standard deviation of monthly climate factors in temperate Mediterranean and cold mountain climates

Climatic factors	Temperate Mediterranean climate	Cold mountain climate
Temperature	r = -0.340 P = 0.008	r = -0.002 P = 0.990
Air pressure	r = 0.502 P = 0.002	r = -0.006 P = 0.961
Rainfall	r = 0.319 P = 0.013	r = -0.02 P = 0.987
Humidity	r = 0.190 P = 0.147	r = -0.270 P = 0.838

Table 2. Relationship between monthly fertility and climatic factors in temperate Mediterranean and cold mountain climates

relationship between temperature and monthly fertility and a direct relationship between air pressure and rainfall as well as monthly fertility were observed. Another finding of this study was that the fertility pattern of women living in the two studied climates was approximately similar, and the highest incidence of fertility was found in the middle of autumn (Figure 1).

Figure 1. Fertility pattern of women in temperate Mediterranean and cold mountainous climates

4. DISCUSSION

Fertility rate is an important health issue worldwide, which is influenced by different factors, including climatic factors, and has attracted the attention of researchers. The present study employed a different point of view and examined the effects of climatic factors, rather than clinical factors, on human fertility. The results obtained revealed a relationship between temperature and monthly fertility in temperate Mediterranean climate, which is consistent with the findings of other studies (16, 21, 22); however, this relationship has not been found in other regions with non-temperate climate (23). Furthermore, temperate Mediterranean climate appeared to exhibit less fluctuations in temperature during night and day, leading to a monthly mean temperature very close to the actual temperature at different hours of the day and night every month. Accordingly, the absence of any correlation between temperature and monthly fertility in Hamedan with cold mountain climate could be because of the high temperature fluctuations during night and day in a month in this region. It was noted that during the day and night, the temperature in this region may reach approximately 15°C and below 0°C, respectively.

Moreover, a correlation between the mean monthly pressure as well as rainfall and monthly fertility was noted in Behshahr with temperate Mediterranean climate, similar to the findings reported in some previous studies (24, 25). Although the mean monthly pressure is a parameter that changes under the influence of atmospheric pressure during the year, overall, depending on the city's height from the sea level, its variations in every region remain within a limited range. Typically, in autumn,

as a result of high pressure currents, the northern and western cold airs reach Iran, resulting in heavy downpour. In contrast, in Hamedan with cold mountain climate, despite maximum fertility found in the month in which maximum air pressure dominates the city (as noted in Behshahr), a significant relationship between the mean monthly pressure and monthly fertility rate was not observed. With regard to the direct correlation observed between monthly fertility and average rainfall in temperate versus cold mountain climate, in Hamedan with cold mountain climate, comprising hot, dry, and no-rainfall summers, cold winters, and approximately 124 days of frost, it was noted that downpour does not follow a regular pattern and is a unique feature of fall and spring (20). However, in Behshahr with temperate climate, it was observed that rainfall occurs throughout the year in all the four seasons and dramatically increases during fall. Thus, the presence of a regular rainfall pattern in Behshahr may support the significant relationship between monthly rainfall and monthly fertility, whereas the irregular rainfall pattern in Hamedan could explain the absence of this correlation in that region.

Finally, the observation of fertility peak during autumn in both the cities may be the result of the unique feature of fall in the two climates, which is characterized by relative temperature decrease, relative pressure increase, and significant increase in rainfall. It is believed that this pleasant coolness during fall may create an appropriate condition for the fertility of the population living in these two cities. These cool environmental conditions have been considered to create suitable physiologic conditions and exert some positive effects on the qualitative and quantitative process of spermatogenesis in men (25, 26). Furthermore, it was observed that the livelihood style and employment based on agricultural productions among almost half of the people living in both the cities generated appropriate economic conditions in these two seasons, resulting in good access to calorie sources, which could have had some positive effects on the productivity potential of women living in these two cities. Lastly, an increase in rainfall in autumn may provide free time for the couples to spend more time with each other, and in this condition, fertility is anticipated to rise. Thus, the three above-mentioned factors were noted to create appropriate physiologic, economic, and social conditions in autumn for fecundity peak among couples in both the regions.

In conclusion, in both temperate and cold mountain climates, with annual regular, continuous pattern and insignificant fluctuations in the climatic factors during day and night, a correlation between climatic factors (temperature, pressure, and rainfall) and monthly fertility was observed. Therefore, it is suggested that in the fertility investigation process, the couples' physiologic, economic, and social factors should also be considered besides the medical factors.

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REFERENCES

1. Greer G. To have or not to have: The critical importance of reproductive rights to the paradox of population policies in the 21st century. *International Journal of Gynecology & Obstetrics*. 2009; 106(2): 148-150.
2. Vallety P. Population paradox: Europe's time bomb, The article in the Independent, August 9, 2008.

3. Strulik H, Prettnner K, Prskawetz A. R&D based growth in the post-modern era. Program on the Global Demography of Aging. Working Paper 74, 2011.
4. Stephenson J, Crane S, Levy C, Maslin M. Population, Development and Climate Change: what are the links and the impacts on human health? *Lancet*. 2013; DOI:10.1016/S0140-6736(13)61460-9.
5. Prettnner K, Bloom DE, Strulik H. Declining fertility and economic well-being: Do education and health ride to the rescue? *Labour Economics*. 2012; Number: 6527.
6. Pinnelli A, Di Cesare M. Human fertility: sociodemographic aspects. *Contraception*. 2005; 72(4): 303-307.
7. Bobak M, Gjonca A. The seasonality of live birth is strongly influenced by socio-demographic factors. *Human reproduction*. 2001; 16(7): 1512-1517.
8. Skakkebaek NE, Jørgensen N, Main KM, Meyts ERD, Leffers H, Andersson AM, et al. Is human fecundity declining? *International journal of andrology*. 2006; 29(1): 2-11.
9. Jensen TK, Andersen AN, Skakkebaek NE. Is human fertility declining? *International Congress Series*. 2004; 1266: 32-44.
10. Tingen C, Stanford JB, Dunson DB. Methodologic and statistical approaches to studying human fertility and environmental exposure. *Environmental health perspectives*. 2004; 112(1): 87.
11. Potts M, Henderson CE. Global warming and reproductive health. *International Journal of Gynecology & Obstetrics*. 2012; 119: S64-S7.
12. Fisch H, Andrews HF, Fisch KS, Golden R, Liberson G, Olsson CA. The relationship of long term global temperature change and human fertility. *Medical Hypotheses*. 2003; 61(1): 21-28.
13. Filippidou E, Koukoulia A. The effects of climate change on the respiratory system. *Archives of Hellenic Medicine*. 2011; 28: 502-515.
14. Balbus JM, Malina C. Identifying vulnerable subpopulations for climate change health effects in the United States. *Journal of Occupational and Environmental Medicine*. 2009; 51(1): 33-37.
15. McMichael AJ, Woodruff RE, Hales S. Climate change and human health: present and future risks. *The Lancet*. 2006; 367(9513): 859-869.
16. Carolan-Olah M, Frankowska D. High environmental temperature and preterm birth: A review of the evidence. *Midwifery*. 2014; 30(1): 50-59.
17. Thomas DS, Twyman C. Equity and justice in climate change adaptation amongst natural-resource-dependent societies. *Global Environmental Change*. 2005; 15(2): 115-124.
18. Lawrence RS, Saundry PD. Climate change, health sciences, and education. *American journal of preventive medicine*. 2008; 35(5): 426-428.
19. Kennaway DJ, Boden MJ, Varcoc TJ. Circadian rhythms and fertility. *Molecular and cellular endocrinology*. 2012; 349(1): 56-61.
20. Modarres R, Sarhadi A. Statistically-based regionalization of rainfall climates of Iran. *Global and Planetary Change*. 2011; 75(1): 67-75.
21. Lam DA, Miron JA. The effects of temperature on human fertility. *Demography*. 1996; 33(3): 291-305.
22. Basu R, Malig B, Ostro B. High ambient temperature and the risk of preterm delivery. *American Journal of Epidemiology*. 2010; 172(10): 1108-1117.
23. Vahidi A, Kalantar SM, Soleimani M, Arjmand MHA, Aflatoonian A, Karimzadeh MA, et al. The relationship between seasonal variability and pregnancy rates in women undergoing assisted reproductive technique. *Iranian Journal of Reproductive Medicine*. 2012; 2(2): 82-86.
24. James WH. Seasonal variation in human births. *Journal of Biosocial Science*. 1990; 22(1): 113-119.
25. Ellison P. Reproductive ecology and human fertility. Applications of biological anthropology to human affairs. 1991: 14-54.
26. Nakahori Y, Sato Y, Ewis AA, Iwamoto T, Shinka T, Nozawa S, et al. Climatic influence on the reproductive characteristics of Japanese males. *Journal of human genetics*. 2012; 57(6): 375-378.