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The effect of preconception housing and living conditions on primary infertility among couples in Gaza Strip, Palestine: A case-control study

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Abstract

Introduction: The aim of this study was to address the relationship between housing and living conditions that couples might experience before and after marriage and primary infertility in Gaza Strip, Palestine.

Methods: A case-control study of 160 infertile couples matched residentially with 160 fertile ones was performed in Gaza Strip, Palestine. Infertile couples were chosen from list of patients registered in five fertility centers from 2016 to 2018. Data was collected through a self-administered questionnaire and analyzed through SPSS program version 22 by using descriptive analysis, cross-tabulation, and binary logistic regression.

Results: A positive association between using private vendors as a source of drinking water before marriage and primary infertility ($P < 0.001$) was demonstrated in females and males. Being a refugee ($P = 0.036$), living near borders ($P = 0.011$), living in extended families ($P = 0.021$), paying for rents ($P = 0.029$), and using septic porous sewer tanks ($P = 0.020$) provided a positive significant relationship after marriage. Odds of drinking water from rooming tanks before marriage was seven times risk in females ((95% Confidential Interval [CI] 1.44 to 32.52,

P = 0.020) mostly ovulatory and idiopathic causes, using septic sewer porous tanks held three times risk (95% CI 1.33 to 6.92, *P* = 0.008) mostly obstructive and ovulatory causes in males and females, respectively and living in extended families held twice risk (95% CI, 1.20-3.56, *P* = 0.009) mostly nonobstructive causes in males and ovulatory and endometrial causes in females.

Conclusion: Our findings provided evidence for the effect of inadequate living conditions on the fertility status of both women and men which opens the gate for further in-depth randomized trials.

KEY WORDS: Gaza Strip; housing; living conditions; primary infertility.

Riassunto

Introduzione: L'obiettivo di questo studio è stato quello di indagare la relazione esistente tra le condizioni di vita e di abitazione di cui le coppie potrebbero fare esperienza prima e dopo il matrimonio e l'infertilità primitiva nella Striscia di Gaza, Palestina.

Metodi: Uno studio caso-controllo con 160 coppie non fertili appaiate per residenza a 160 coppie fertili è stato effettuato nella Striscia di Gaza, in Palestina. Le coppie non fertili sono state scelte dalla lista di pazienti registrata in 5 centri per la fertilità dal 2016 al 2018. I dati sono stati raccolti con un questionario auto-somministrato e sono stati analizzati con il programma SPSS versione 22, attraverso un analisi descrittiva, tavole incrociate ed una regressione logistica binaria.

Risultati: Un'associazione positiva è stata dimostrata nei soggetti di sesso maschile e femminile tra l'uso di fornitori privati di acqua potabile prima del matrimonio e l'infertilità primitiva (*P* < 0.001). La condizione di rifugiato (*P* = 0.036), vivere vicino ai confini (*P* = 0.011), vivere in famiglie allargate (*P* = 0.021), pagare l'affitto (*P* = 0.029), e l'uso di vasche e canali porosi infetti (*P* = 0.020) ha fornito una significativa relazione dopo il matrimonio. Bere acqua da serbatoi

ammobiliati prima del matrimonio costituiva un rischio sette volte maggiore nei soggetti di sesso femminile ((95% Confidential Interval [CI] 1.44 to 32.52, *P* = 0.020) soprattutto per cause idiopatiche o dovute all'ovulazione, usare vasche e canali porosi infetti un rischio maggiore di tre volte (95% CI 1.33 to 6.92, *P* = 0.008) soprattutto per le cause ostruttive ed ovulatorie rispettivamente nei maschi e nelle femmine, vivere in famiglie estese costituiva un rischio doppio (95% CI, 1.20-3.56, *P* = 0.009) soprattutto per cause non ostruttive nei maschi ed ovulatorie nelle femmine.

Conclusione: I nostri risultati hanno fornito evidenza dell'effetto che le inadeguate condizioni di vita possono avere sulla fertilità di donne ed uomini e ciò apre la ricerca ad ulteriori studi clinici più approfonditi di tipo randomizzato.

TAKE-HOME MESSAGE: Inadequate living conditions before marriage, such as living in overcrowded homes and relying on private vendors to obtain drinking water, appeared to negatively affect the reproductive capacity of an individual. After marriage, primary infertility was found to be associated with poor toilet facilities, living in extended families and paying for rents.

Competing interests: none declared

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INTRODUCTION

Failure to conceive is considered one of the most distressful reproductive health conditions that is common globally but with higher rates in the developing countries [1]. The World Health Organization recognizes infertility as a public health problem in terms of physical and mental health for both partners, although it is not recognized till couples determine to endure a child [2]. Accordingly, the WHO defined clinical primary infertility as a condition that refers to "inability to conceive despite cohabitation and exposure to risk of pregnancy for a period of 12 months or more in a sexually active non-contracepting, and non-lactating women 15 to 49-year-old" [3]. According to a global, national and regional systematic analysis of 277 demographic and reproductive health surveys, the rate of primary infertility was announced to be 1.9%, which formed about 50 million couples around the world in 2010 and which was quite similar to those in 1990 that formed around 42 million couples then [4]. In 2004, the WHO estimated a 186 million couples in developing countries as suffering from infertility, from which 18 million (2.5%) were primary infertile [1]. Due to the variety in definitions used in assessment techniques and the slight increase in global support to research, monitoring and evaluation of the unmet needs in this particular public health area and the identification of the regional burden in the developing countries has been extremely limited [5].

Being an important public health problem, there have been continuous efforts to explore modifiable risk factors lying beyond the apparently well-established aetiologies, and to consider risk factors modification as a prerequisite in potential management methodologies [6]. Many researchers agree that the majority of risk factors causing primary infertility are preventable [7–9]. Risks that may include obesity, lack of physical activity, exposure to certain chemicals, smoking and other environmental and behavioural factors, are believed to negatively impact the

reproductive ability of couples [10–13]. In addition, unsatisfactory living conditions due to financial constrains was unexpectedly found to be among the predictors of infertility in females [14], providing that preconception stress, inadequate housing and improper basic life facilities are concomitant factors for both infertility and unsatisfactory living conditions [15]. Taking all that into consideration should provide a methodological insight for the role of social determinants of health in explaining various traceable causalities related to well-established diagnosis or even idiopathic causes of infertility [16]. Nevertheless, little is known about the implications of various living conditions that couples might experience before or after marriage and the impact of such exposure on their conceiving ability.

Accordingly, the aim of this paper was to demonstrate different living conditions, including household size, birth order, residency, type of family, type of housing unit, tenure of house, sanitary system used and sources of drinking water, and how these factors would be associated with primary infertility in males and females.

METHODS

Study design and procedure

The study design of this original article was based on a retrospective observational analytic case-control study that was conducted in Gaza Strip, Palestine in 2019. The practicality and feasibility of this design was typically indicated to explore various housing and living-related risk factors that are associated with primary infertility. By using the observational property of this design, the researchers intended to examine the relationship between multiple exposures (housing and living conditions) against a single outcome of interest (primary infertility) in a study population with the same study base. Adding to that, analytic methods were used to estimate the strength of associations that have been concluded through the course of result findings.

Study participants and sampling

The researchers recruited 320 couples for the study, from which 160 were known to have primary infertility based on the clinical definition of the WHO [3] and another 160 fertile couples who were congruent with the controls' inclusion criteria. Cases group included married, sexually active couples in the reproductive age period (18-49), who were unable to conceive despite exposure to the risk of pregnancy for a period of at least one year. They were matched residentially with fertile couples in the reproductive age period (18-49), who were recognized as having at least two successful pregnancies with no history of assistive reproductive techniques and who were not known to have clinical infertility during their life time. Being a case control study, it was more appropriate to use the following in calculating the sample size; a confidence level of 95% (how precise I want my estimate to be), a power of 80% (the probability of finding an association when an association actually exists), a ratio of cases to controls of 1 and a percentage of exposed controls of 50% as there is limited information about the exposure among the control group. When the total population with primary infertility in Gaza Strip was 15,048 couples according to what has been estimated and stated by Palestinian Center Bureau of Statistics, the researcher used epi-info 7 sample size statistical calculator and had 148 subjects for each group as the required sample size. In order to compensate missing or non-responding cases, the researcher increased the number of cases to 160 and accordingly increased the controls to 160 to have a total of 320 couples as a sample size for the study.

Multistage sampling technique was used to select the calculated sample of cases. To define the sample frame, five fertility centers were randomly chosen from total nine centers allocated in Gaza Strip. The population frame was defined as the lists of couples who had registered in these fertility centers seeking medical advice for primary infertility from January 2016 till December

2018. In each center, the patients registered in the aforementioned period were classified into sub clusters according to their residency. Finally, a 4th couple was chosen from each sub cluster (North Gaza, Gaza, Middle Area, Khan Younis and Rafah) through a systematic stratified sampling technique. Since the breakdown of total female population in reproductive age according to governorate are 88,042 in North Gaza, 155,385 in Gaza, 66,858 in Middle Area, 86,260 in Khan Younis and 55,630 in Rafah, that represent 19%, 34%, 15%, 20% and 12% respectively, the number of patients extracted systematically for each sub cluster were governed by this distribution [17]. On the other hand, the researchers sought couples of the control group from Governmental primary health care clinics who approached for maternal and child care services and who were congruent with the residency of the corresponding cases.

Upon reviewing literature for primary infertility in particular and reproductive health in general, a face to face interviewed questionnaire was self-constructed and developed, typically to achieve the intended objectives and formalized to be pertinent to the environmental and social characteristics of the study setting. For validation, ten experts, including gynaecologists, epidemiologists, public health specialists and statisticians, participated in reviewing the instrument and further modification was applied upon their comments. Data collectors deployed to collect information were chosen as having high experience and affinity with the data collection procedure and with the study population as well. They were provided with sufficient background knowledge about the study and were trained on the research instrument to guarantee standardization, minimize inter-observer variation and eventually assure reliability of the study. A comprehensive training was delivered on the content of the instrument, the way questions are provided, the type of terms and digits used in recording and the technique to compare responses with medical reports and records. As a final step, a cognitive qualitative testing of the

questionnaire was performed through an iterative pilot work on members from the selected sample, after which the questions' format were optimized to be fully comprehended by the respondents and the instrument was explored to full achieve the purpose of the study.

Ethical aspects

In order to launch this study, an academic approval from the School of Public Health at Al- Quds University was obtained after submitting the study proposal to the research committee for discussion. Subsequently, an ethical approval was obtained from the ethical committee in Gaza Strip (Helsinki Committee, approval number PHRC/HC/548/19). In the perspective of commitment to research ethics, the researcher was committed to provide an informed consent along with each questionnaire and guaranteed that each participant was fully aware and fully acquainted with each section of the attached consent form, emphasizing on their right to withdraw participation at any time. The consent explained the aim of the study along with clarification about voluntary participation with making sure that confidentiality is highly implemented. Additionally, an administrative approval was acquired from the director of Ministry of Health, as well as the specialists running the fertility centers for the purpose of having access to the institutions' database. It is also worthy to mention that data of this study was drawn by the same research-project of a previous publication of the effect of nutrition on primary infertility in Gaza Strip [18].

Data analysis

Data entry was performed using IBM SPSS Statistics 22 and quality of the data was verified by refilling invalid questions through phone calls paid to the related subjects. Upon completing the process, 5% of the data was re-filled to ensure high level of procedure accuracy. Before analysis, the data was coded, where required, and was cleaned for any errors or unlogic values. Then,

descriptive statistical analysis was deployed to provide the distributions of ordinal (e.g. birth order, household size) and nominal (e.g. type of dwelling, type of toilet facility) variables in frequencies and percentages. Crude odds ratio was calculated for each independent variable against the fertility status of both groups and across causes of primary infertility in females and males through cross tabulation chi square analysis. Finally, to predict the estimated risk of each independent variable and to adjust confounding effect, an adjusted odds ratio was obtained through binary logistic regression involving independent variables that had shown statistically significant relationship with primary infertility.

RESULTS

Table 1 demonstrates variables of different living conditions for both females and males individually before marriage and as couples after marriage. Exploring living conditions before marriage revealed that, 11 (7%) females in the infertile group compared to 31 (13%) of the fertile group used to live in a household that comprise less than 6 inhabitants, 95 (59%) and 83 (52%) respectively lived in 7-10 household size, and 3 (2%) compared to 13 (8%) respectively used to live with more than 10 inhabitants. Men showed 19% and 12% respectively for less than 6 household size, 49% and 47% for 7-10 and 31% compared to 41% respectively used to live in a household size of more than ten. Birth order for females did not provide a significant association, but the frequency of men born as the 7th sibling in the fertile group (14%) was double the fertile ones (7%), giving a relationship that approached a statistically significant level, (OR = 2.77, (95% Confidential Interval [CI] 1.21 to 6.34, $P = 0.014$).

Results also showed that, the most prevailing source of drinking water used by females in the infertile group before marriage (85%) was the rooming tanks, compared to only about half of those of the control group (55%), while less cases reported using municipal water/protected wells

(17%) or filter/mineral water (3%) than control couples (33%, 11% respectively). Almost the same distribution was noticed among the male partners, where 91% of men in the infertile group and 61% of the fertile ones reported rooming tanks as the main source of drinking water before marriage, 17% and 13% respectively used municipal water and/or wells and 2% and 8% respectively use home installed filters or mineral water. The relationship in both situations is highly statistically significant, when considering filters and/or mineral water as the reference.

Positive refugee status was detected more among infertile couples than fertile couples (70%, 58.8% respectively, $p < 0.05$). Living inside camps did not differ much between both (31.2%, 32.5% respectively), but a significant difference appeared among those living near borders (28.5%, 17.2% respectively). From all infertile male partners who were living near borders, 25 (27%) suffered from oligospermia, 2 from azoospermia, pyospermia and high semen viscosity for each and one as having undescended testis, one with anti-sperm antibodies and one with ejaculatory disorder. Eleven (12%) of the total infertile men were known to have idiopathic causes. On the other hand, of all infertile women living near borders 15 (16.3%) were diagnosed with Polycystic Ovary Syndrome, 5 with diminished ovarian reserve, one with endometriosis, one with hyperprolactinemia and 11 (12%) were concluded to have idiopathic causes.

Exploring the type of family after marriage revealed that, 53 (33%) of the infertile group reported living in extended families, compared to 33 (21%) of their counterpart, providing a statistically significant association. Additionally, when most of the surveyed couples (80%) declared self-owning the house they are currently living in, there was apparent difference between infertile (74.4%) and fertile (85.6%) couples, while 11.3% compared to 7.5% respectively reported living in a house without payment. The main contributor to the positive significant association was attributed to those who were living in housing units and pay for rents

on monthly or annual basis, OR = 2.41 (95% CI 1.13 to 2.14, *P* = 0.02). The relationship between couples living in a single room (24 infertile and 17 fertile) as a part of an extended family or living in an independent house/apartment (136 and 143 respectively) were not statistically significant. Moreover, data collected about the type of sanitation system used by participants' households showed that 136 (85%) infertile couples had their household unit connected to a piped public sewer system, compared to 149 (93.1%) fertile ones. The remaining 24 couples, representing 15% of the total cases, had their household units' sewer system connected to septic porous tanks compared to 11 (6.9%) respectively, providing a twice more likely risk for being infertile, OR = 2.39 (95% CI 1.13 to 5.06, *P* = 0.02).

Table 1. Cross tabulation between primary infertility and variables of various living conditions.

Variables of living conditions	**Category**	**Infertile couples**	**Fertile couples**			
		n (%)	**n (%)**	**OR**	**95% CI**	***P*-value**
Female partner						
Household size before marriage	≤ 6	11 (6.9)	21 (13.1)		Ref	
	7–10	95 (59.4)	83 (51.9)	2.18	(0.99-4.80)	*0.047
	> 10	54 (33.7)	56 (35.0)	1.84	(0.81-4.18)	0.141
Birth order	1st – 3rd	79 (47.5)	78 (48.7)		Ref	
	4th – 6th	54 (33.7)	52 (32.5)	1.02	(0.63-1.68)	0.921
	≥ 7th	30 (18.8)	30 (18.8)	0.99	(0.54-1.79)	0.966
Source of drinking water before marriage	Rooming tanks	128 (80.0)	89 (55.6)	5.18	(1.85-14.46)	**<0.001
	Municipal water/ Wells	27 (16.9)	53 (33.1)	1.83	(0.61-5.47)	0.273
	Filter/Mineral water	5 (3.1)	18 (11.3)		Ref	
Male partner						
Household size before marriage	≤ 6	31 (19.4)	20 (12.5)		Ref	
	7–10	79 (49.4)	75 (46.9)	0.68	(0.36-1.29)	0.239
	> 10	50 (31.2)	65 (40.6)	0.50	(0.25-0.97)	*0.040

Birth order	1st – 3rd	97 (60.6)	96 (60.0)		Ref	
	4th – 6th	40 (25.0)	53 (33.1)	0.75	0.45-1.23	0.250
	≥ 7th	23 (14.4)	11 (6.9)	2.07	0.96-4.48	0.061
Source of drinking water before marriage	Rooming tanks	129 (80.6)	98 (61.3)	4.28	(1.35-13.53)	*0.007
	Municipal water/ Wells	27 (16.9)	49 (30.6)	1.79	(0.53-6.04)	0.343
	Filter/Mineral water	4 (2.5)	13 (8.1)		Ref	
As couples						
Refugee status	Refugees	112 (70.0)	94 (58.8)	1.64	1.03-2.60	*0.036
	Non-refugees	48 (30.0)	66 (41.3)			
Residency; camps	Outside camps	110 (68.8)	108 (67.5)	1.06	0.66-1.69	0.810
	Inside camps	50 (31.2)	52 (32.5)			
Residency; area	Near borders	57 (35.6)	35 (21.9)	1.98	1.20-3.24	*0.011
	Away from borders	103 (64.4)	125 (78.1)			
Family type	Extended	53 (33.1)	33 (20.6)	1.91	1.15-3.16	*0.012
	Nuclear	107 (66.9)	127 (79.4)			
Tenure of housing unit	Rent	23 (14.4)	11 (6.9)	2.27	1.07-4.84	*0.029
	Owned	137 (86.6)	149 (93.1)			
Type of dwelling	Room or caravan	24 (15.0)	17 (10.6	1.48	0.76-2.88	0.242
	Independent house, apartment	136 (85.0)	143 (89.4)			
Toilet facility	Septic porous tank	24 (15.0)	11 (6.9)	2.39	1.13-5.06	*0.020
	Piped sewer system	136 (85.0)	149 (93.1)			

* Significant at $P < 0.05$, **Highly significant at $P < 0.001$

The distribution of females' infertility causes across variables of living conditions are demonstrated in Table 2. Data show that ovulatory causes of infertility are two times more among females who used rooming tanks as a main source of drinking water before marriage comparing to those who used municipal and/or filter water (95% CI 1.18 to 4.45), endometrial causes are six times more (95% CI 1.04 to 22.09), and idiopathic causes are seven times more

(95% CI 2.26 to 26.36). Living near borders was two times risky to develop ovulatory infertility (95% CI 1.23 to 4.48), while living in extended families and using septic porous sewer tanks showed three times risk for endometrial causes (95% CI 1.26 to 11.74) and ovulatory causes (95% CI 1.23 to 7.73), respectively.

Table 2. Distribution of females' infertility causes among living condition variables.

Variables	**Control (n: 160)**	**Ovulatory (n = 58)**			**Endometrial (n = 14)**			**Hormonal (n = 10)**			**Idiopathic (n = 32)**		
	n	n	OR	*P*-value	n	OR	*P*-value	n	OR	*P*-value	n	OR	*P*-value
Drinking water before marriage													
Rooming tanks	89	43	2.45	0.007	12	5.98	0.009	8	3.19	0.131	29	7.71	<0.001
Municipal water/ Filter	71	15			2			2			3		
Refugee status													
Refugees	94	36	1.15	0.659	10	1.75	0.356	7	1.64	0.482	20	1.17	0.693
Nonrefugee	66	22			4			3			12		
Residency													
Near borders	35	23	2.35	0.008	2	0.59	0.506	2	0.89	0.889	11	1.87	0.130
Away from borders	125	35			12			8			21		
Family type													
Extended	33	19	1.87	0.06	7	3.84	0.012	3	1.65	0.481	8	1.28	0.581
Nuclear	127	39			7			7			24		
Tenure of housing unit													
Rent	11	3	0.75	0.671	1	0.85	0.877	1	1.51	0.708	5	2.51	0.102

Owned	149	54			13			9			27		
Toilet facility													
Septic Porous tank	11	10	3.08	0.013	0			1	1.50	0.708	6	3.12	0.031
Public sewer system	149	44			14			9			26		

Ovulatory causes = polycystic ovaries, diminished ovarian reserve, primary ovarian insufficiency, anovulation; Endometrial causes = endometriosis, uterine fibroids, ovarian endometriomas, Hormonal = high FSH, hyperprolactinemia, hypothyroidism; OR = Odds Ratio, *P* value = Level of significance

Table 3 shows the relationship between different living conditions and causes of male infertility among the surveyed population. All causes of male infertility revealed to hold a risk among those who used rooming tanks as a main source of drinking water (95% CI 1.44 to 4.68, Non-Obstructive causes; 95% CI 2.00 to 38.58, Obstructive causes; 95% CI 2.26 to 26.36, Idiopathic causes). Non-Obstructive causes was two times more among refugees (95% CI 1.07 to 3.36), living near cross borders (95% CI 1.15 to 3.66), living in extended families (95% CI 1.17 to 3.78) and those who pay rent for household setting (95% CI 1.27 to 6.65). Using septic porous tank as a sewer drainage system revealed to hold two times and three times risk for Non-Obstructive (95% CI 1.15 to 6.18) and Idiopathic (95% CI 1.06 to 9.19) causes of infertility among men respectively.

Table 3. Distribution of males' infertility causes among living condition variables.

Variables	**Control (n: 160)**	**Non-Obstructive (n = 85)**			**Obstructive (n = 24)**			**Idiopathic (n = 32)**		
	n	n	OR	*P*-value	n	OR	*P*-value	n	OR	*P*-value
Drinking water before marriage										
Rooming tanks	89	65	2.59	0.001	22	8.77	<0.001	29	7.71	<0.001
Municipal water/ Filter	71	20			2			3		
Refugee status										
Refugees	94	62	2.15	0.007	17	1.94	0.160	20	1.33	0.473

Nonrefugee	66	23			7			12		
Residency										
Near borders	35	31	2.05	0.014	8	1.78	0.216	11	1.87	0.130
Away from borders	125	54			16			21		
Family type										
Extended	33	30	2.10	0.012	9	2.31	0.066	8	1.28	0.581
Nuclear	127	55			15			24		
Tenure of housing unit										
Rent	11	15	2.90	0.009	3	1.93	0.332	5	2.51	0.102
Owned	149	70			21			27		
Toilet facility										
Septic Porous tank	11	14	2.67	0.018	3	1.93	0.332	6	3.12	0.030
Public sewer system	149	71			21			26		

Non-Obstructive causes = Abnormal Spermatogenesis, Anti-sperm antibodies, Asthenospermia, Azoospermia, Pyospermia, Oligospermia, Necrospermia, Low sperm motility, Varicocele, Bilateral undescended testis, Obstructive causes = Ejaculatory disorders, Epididymal obstruction, Prostatic enlargement, One testis, High semen viscosity, OR = Odds Ratio, *P* value = Level of significance

Several independent variables were identified as having a statistically significant association with primary infertility, that might interact and affect each other. Hence, the covariance among these variables and the possible confounding effect was resolved by using binary logistic regression analysis. The model shown in Table 4 had a predictive capacity of 61%. It also showed that using rooming tanks as a source of drinking water before marriage for females was more than 6 times likely among infertile women than fertile ones, while living in extended families as couples showed a double risk. Being a refugee did not appear to be significant, but paying rents for living held two times risk and using septic porous sewer tanks instead of being connected to the public sanitary network provided a three times risk.

Table 4. Determinants of primary infertility (Binary logistic regression).

Independent variables	Exp (B)	95% CI	*P*-value

Drinking water (Females) Filter/Mineral=Reference	6.84	1.44 – 32.52	*0.016
Drinking water (Males) Filter/Mineral= Reference	0.83	0.15 – 4.68	0.837
Refugee status (Couples) Nonrefugee=Reference	1.45	0.88 – 2.39	0.148
Family type (Couples) Nuclear=Reference	2.07	1.20 – 3.56	*0.009
Tenure of house (Couples) Owned=Reference	2.32	1.04 - 5.21	*0.041
Toilet (Couples) Public system=Reference	3.03	1.33 – 6.92	*0.008

Exp (B)=Exponentiation of B coefficient; CI=confidence interval; Model coefficient chi^2=51.68, $P < 0.001$; Nagelkerke r^2=0.172; Membership for cases; * Significant at $P < 0.05$

DISCUSSION

In this study, we retrospectively explored variant living conditions that the couples in Gaza Strip are experiencing before and after marriage and the implication of such exposure on their fertility status. The study was conducted through examining 160 infertile couples attending fertility centers for treatment and matched residentially with another 160 fertile couples attending governmental primary health care clinics for maternal and child health care. Inquiries about some living conditions that couples were involved in before marriage and which was sought as relevant to our subject of concern revealed that, men who used to live in an overcrowded household setting (+10 inhabitants) are more prone to primary infertility, although birth order did not seem to have a significant effect. To our knowledge, no previous studies have addressed this particular area before, which provide an opportunity for further in-depth investigation. However, it has been suggested that later born siblings have lower physical fitness in late adolescence than first born one [19]. This is usually more prominent in societies with high household size (5.6 persons per household in Gaza Strip) [17], where sharing the parental resources' pool among

offspring is mostly unequal [20]. This could also be related to childhood exposure to poverty, under-education and child labour, which has been frequently suggested to be relevant to large size families [21], but with lack of sufficient evidence on its role on the fertility status of upgrowing individuals later in life.

One of the essential components of public health is the human right to access clean and safe water [22]. Upon studying this particular area, people living in Gaza Strip seemed to depend on five main sources of drinking water; municipal source piped into dwelling, protected and unprotected wells, rooming tanks through private vendors, mineral water and home installed filters [17]. A highly significant association was found between using rooming water tanks as a main source of drinking water before marriage and primary infertility in both females and males. Stratification the data showed that females presented with idiopathic cause of infertility scored the highest risk, followed by those who were suffering from uterine fibroids, endometriosis and ovarian endometriomas. The associated risk among men was mostly presented as obstructive infertility including ejaculatory disorders, epididymal obstruction, prostatic enlargement or high seminal viscosity. A significant risk was also detected among idiopathic infertile men and those with non-obstructive causes mainly with abnormal spermatogenesis, anti-sperm antibodies, oligospermia, varicoceles and low sperm motility. Congruent to our results, it has been found that fluoride content of drinking water is essential for the ability of conceiving and provide less percentage of abortion and infertility [23]. Others found that endocrinal disruptors, which are environmental chemicals that disturb the reproductive hormonal pathway, like the estrogenic component of combined oral contraceptive pills, can leek to the underground water and can cause infertility in certain occasions [24]. These findings would provide an opportunity for further serious public health measures to be negotiated and formalized by policy makers and

environmental specialist for the sake of continuous water supply quality assessment and control.

Palestine, and in particular Gaza Strip, has a unique demographic context. The population, who are living in a small geographical area, are divided in to two groups; refugees and non-refugees; and are affected with different social determinants that may affect their health through different perspectives [25]. In this particular study, being a refugee is significantly associated with the occurrence of primary infertility, although living inside or outside camps did not make difference on the outcome. Though, results should be carefully regarded because reporting living outside camps, as a current event, did not exclude spending childhood and adolescence period in camps which was, however, not explored in this study. Adding to that, living near cross borders was 98% more likely among infertile couples compared to those living downtown, in agricultural areas and on the Mediterranean Sea coast. Couples living near borders usually rely on agriculture and livestock as a primary source of income and their educational attainment is often low. Moreover, marginalized areas are known to lack proper sanitary and water system which may add to the burden that already exists [26]. Having non-obstructive causes, mainly azoospermia, in males and ovulatory causes, mainly Polycystic Ovaries, in females as the prevailing cause of infertility in these geographical areas may open the way to ask about the reasons behind the existence of such associations and may offer an opportunity for further securitizing and investigations. Furthermore, living in an extended family after marriage was found to hold a risk on the fertility status of couples. Chronic stress associated with poor housing conditions [27] and residential instability may contribute negatively on health outcomes [28]. Also, there is growing evidence that preconception stress possesses a potential risk on the fertility status of couples [29, 30].

In the same respect, housing tenure is usually concomitant with the social determinants of health

[31], which is also related to the living conditions that surround public and possess certain influence on health [27]. When most of the surveyed couples (80%) declared self-owning the house they are currently living in, there is apparent difference between infertile (86.6%) and fertile (93.1%) couples. The main contributor to the significant relationship between the two groups was detected among those who are living in housing units and pay for rents on monthly or annual basis, in which most of these couples were found to have a non-obstructive male disease as the cause of primary infertility. On the other hand, the type of dwelling were couples used to living in after marriage, whether a room, caravan, independent house or apartment, did not appear to be related to infertility.

Inadequate sanitation in Gaza Strip is a chronic and escalating crisis where about one third of the total household settings are not connected to the public network [32]. In this study, 11% of total couples declared relying on uncovered pits or septic porous tanks as a sewage disposal mean, in which they were more than two times likely to be infertile than those who were living in household settings that are connected to the public sewer network. Based on these results, which are for our knowledge the first to be conducted in this study setting, in addition to the current unstable political situation and the scarcity of financial support, it seems to be more appropriate to rely on expanding the role of reproductive health education and self-hygiene promotion among adolescents and young adults [33] and to enforce the development and implementation of sexual and reproductive health guidelines in the primary health care system that involve sanitation and hygiene education [34, 35].

In conclusion, the study showed that various housing circumstances and different living conditions could affect the fertility status of couples living in Gaza Strip. Our findings suggest that living in a crowded household setting and relying on rooming water tanks for drinking water

are among the premarital factors that affect fertility. Also, being a Palestinian refugee in Gaza Strip, accommodating near cross borders, living in extended families, living in rented houses and/or using improper sanitary system for sewer disposal were found to be among the factors that affect fertility after marriage. Because of the unstable political situation and the chronic financial insecurity in Gaza Strip, policy makers may find it more appropriate and feasible to direct national efforts towards improving housing conditions and providing safe and clean water supply, as well as fostering reproductive health education and promotion mainly among adolescents and young adults.

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