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Sex ratio of children born to Orthopedic surgeons in Jordan: a National Cross-sectional study.

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ABSTRACT

The secondary sex ratio at birth is typically stable worldwide, but some evidence suggested that radiation exposure among surgeons may influence offspring ratio. This national cross-sectional survey of 92 orthopaedic surgeons in Jordan collected data on demographics, offspring sex, fluoroscopy exposure, and compliance in using radiation protection.

Participants reported 260 children, of whom 123 were male 47.3% and 137 were female 52.7%. No significant association was found between offspring sex ratio and weekly fluoroscopy exposure (P value = 0.25), or the use of radiation protection measures (P value 0.2). Although adherence to protective equipment varied, these behaviours showed no measurable reproductive effect. The study concludes that orthopaedic surgeons in Jordan have a slightly higher proportion of female children but this was not related to the occupational exposure, while the high rate of inadequate radiation safety compliance remains a notable occupational concern

1. INTRODUCTION

The secondary sex ratio at birth(SRB), typically expressed as the number of male live births per 100 female live births(1), is a valuable indicator of population health. Under natural conditions, the SRB remains relatively stable across most populations, averaging around 1.05(105 males for every 100 females). However, deviations from this baseline have been observed in association with various environmental and occupational exposures, causing substantial scientific inquiry over the past several decades(1).

Among the medical professionals, it is widely speculated that radiologist and orthopaedic surgeons due the frequent use of fluoroscopy, are more likely to have daughters(2). While some study supports this claim(2,3), other report no significant association(4). These inconsistent findings requires the need for further research, particularly in the understudied regions like the Middle East.

The increase in the use of fluoroscopy-guided procedures during surgeries has led to a rise in ionising radiation exposure to orthopaedic surgeons(5). Yet, the potential reproductive risks associated with such practices remain poorly understood. While existing literature highlights the critical importance of radiation safety measures, including lead aprons, thyroid Shields, and dosimeter use, adherence to these protocols is highly variable(6).

This study aims to evaluate the sex ratio among the offspring of orthopedic surgeons, and to investigate its potential association with occupational radiation exposure.

2. STUDY DESIGN AND METHODS

This study used the national cross-sectional design, involving practising orthopaedic surgeons across all major healthcare sectors in Jordan, including Ministry of Health(MOH), private hospitals, University Hospitals, and the Royal Medical Services(RMS) . The aim was to capture a representative sample of the national orthopaedic workforce and evaluate the offspring sex ratio in relation to clinical practice patterns and occupational exposure.

Data collection was conducted using a structured self-administered questionnaire distributed as a Google form. The questionnaire was organised into three main components , the first section collected demographic information, including the surgeons age, years of experience, level of training, and primary area of practice. This ensured that the sample reflected a broad range of professional backgrounds across all orthopaedic community. The second section focused on offspring sex ratio and asked participants to report the total number of biological children and the number of female children specifically, allowing calculation of the secondary sex ratio for each surgeon.

The third component examined radiation protection behaviour during fluoroscopy guided procedures, this section explored the surgeons routine use of protective measures such as lead aprons and thyroid shields, as well as their general adherence to standard radiation safety practices within the operating theatre. The purpose of this component was to evaluate whether individual differences in using radiation protection might correspond to variations in offspring sex composition. All responses were collected anonymously.

3. RESULTS

A total of 92 orthopaedic surgeons participated in the study, representing public, private military, and academic healthcare sectors across Jordan. Their demographic characteristics are summarised in Table 1. Showing a broad distribution of consultants, specialists, and residents. Participants collectively reported 260 biological children, providing sufficient data set to analyse sex distribution in relation to occupational exposure patterns.

Table 1. Demographic Characteristics of Participating Orthopaedic Surgeons (n = 92)

Variable	Category	n	%
Age	25–30 years	4	4.3%
	31–35 years	25	27.2%
	36–40 years	32	34.8%
	41–45 years	11	12.0%
	>45 years	20	21.7%
Practice Area	MOH	31	33.7%
	Private Sector	31	33.7%
	RMS	20	21.7%
	University	4	4.3%
	Combined MOH + University	6	6.5%
Professional Level	Resident	20	21.7%
	Specialist	34	37.0%
	Consultant	38	41.3%
Years in Practice	<5 years	18	19.6%
	5–10 years	28	30.4%
	>10 years	46	50.0%

Among the reported offspring, 123 were male (47.3%) And 137 were female(52.7%) as shown in Table 2.

Table 2. Offspring Sex Ratio Among Orthopaedic Surgeons (Total Children = 260)

Sex of Child	Number	Percentage (%)
Male	123	47.3%
Female	137	52.7%

Fluoroscopy exposure patterns showed no identifiable relationship with offspring sex distribution (p value 0.25). Surgeons were grouped according to weekly fluoroscopy workload, and each category demonstrated a similar balance of male and female children, with no consistent trend suggesting a shift toward either sex. Variations observed between exposure groups were minor and did not suggest any exposure-related influence.

Radiation protection behaviour showed a similar pattern Table 3. Although the frequency of lead apron use varied across participants, the distribution of offspring sex composition showed no clear biological trend(P value 0.2), as shown in Table 3. While small fluctuations were noted these appeared irregular and likely reflected normal variation rather than any other occupational effect.

Table 3. Radiation-Protection Behaviour and Offspring Sex Composition

Lead-Apron Use Frequency	n Surgeons	More Daughters (%)	More Sons (%)	Equal (%)
Never	15	20.0	46.7	33.3
Rarely	19	31.6	36.8	31.6
Sometimes	20	55.0	25.0	20.0
Frequent	20	60.0	30.0	10.0
Always	18	38.9	50.0	11.1

4. DISCUSSION

The findings of this study shows that the proportion of female children among Jordanian orthopedic surgeons was slightly higher than the expected national and global estimates reported by The World Health Organisation (WHO), and previous population-based studies(7). However, this modest increase did not demonstrate any association with the factors evaluated, including weekly fluoroscopy exposure, lack of radiation protection use, and surgeons' demographics.

A key strength of this study is the inclusion of orthopaedic surgeons from all major sectors and levels of practice across Jordan, providing a representative sample of the national orthopaedic community.

The pattern of inconsistent lack of protection from radiation intraoperatively highlights an important Occupational Safety concern. While the findings suggest no observable reproductive effect from current exposure levels, poor adherence to radiation protection remains a relevant issue for long term health risks(7). Addressing compliance through improved training, enforcement of safety protocols, and institutional support may benefit surgeon safety irrespective of the reproductive outcome.

5. CONCLUSION

The findings of this study reflect a pattern similar to previous literature in which orthopaedic surgeons tend to have slightly higher proportion of female children. However, no association between this observation and the floors could be exposure was identified

The data clearly demonstrate a high rate of non-compliance with radiation protection measures among orthopaedic surgeons, highlighting an important Occupational Safety issue that requires attention

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