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PREVALENCE AND PREDICTORS OF WORK-RELATED MUSCULOSKELETAL COMPLAINTS AMONG OIL AND GAS WORKERS

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ABSTRACT

Introduction: Employees in the oil and gas sector are constantly at risk of harm or death because of the unique nature of their jobs, which includes a range of hazardous products and working conditions. **Aim of Work:** To study the prevalence of musculoskeletal problems, to investigate its associations with risk factors and pinpoint its predictors among Egyptian Oil and Gas workers. **Materials and Methods:** A cross-sectional study was conducted on 410 workers at the "Engineering for Petroleum and Process Industries Organization" (Enppi). A questionnaire was used to collect information about the participants' sociodemographic, employment status, and risk factors. The Nordic questionnaire was also used to assess musculoskeletal problems among the studied group. **Results:** In the 12 months preceding the research, 79% of the participants reported musculoskeletal complaints in one or more body areas, with the lower back (56.9%) and neck (54.1%) were the most frequent sites. The prevalence of musculoskeletal complaints was significantly related to age, gender, years of employment, and daily hours worked, with biomechanical and environmental factors, including sustained body posture, repetitive motion, improper furniture, insufficient lighting and bad ventilation. When comparing those who reported musculoskeletal problems to those who did not, the following organizational and psychosocial risk

factors were significantly higher: multitasking, inadequate training, continuing to work when in pain, and low job control. The most important predictors of work-related musculoskeletal complaints were working for more than 15 years, sustained posture, having inadequate ventilation, and continuing to work despite discomfort or injury. **Conclusion and Recommendations:** There was a high prevalence of work-related musculoskeletal complaints among workers in oil and gas workers. The current study shed the light to the need of adopting interventions and preventive measures for a more supportive and sustainable working environment.

Key words: Work-related musculoskeletal complaints, Oil and Gas workers, Nordic questionnaire, and environmental factor.

Introduction

Musculoskeletal disorders (MSDs) are a wide-ranging term labeling a diversity of diseases and injuries affecting muscles, tendons, ligaments, joints, and bones. MSDs may affect the back, cervical area, upper and lower extremities, causing discomfort and disability. Work related musculoskeletal disorders (WMSDs) are considered one of the most prevailing problems among the workers in several diligences (Bonfiglioli et al., 2022).

WMSDs are a major contributor to chronic disability and illness which in turns leads to functional disability, reduced work productivity and, consequently impaired the quality of life and lead to loss of work time with monetary repercussions for the individual, employers, and society (Fan et al., 2024).

WMSDs are complex in nature, with biomechanical, psychological, organizational, individual, and environmental factors all potentially contributing to their development (Das et al., 2020; Das, 2022). Many researches have found that WMSDs on different body areas have distinct risk factors. When these single independent factors were collected together, the probability of WMSDs increased (Keir et al.,2021).

As the fossil fuels are still essential sources of energy, the oil and gas sector plays a vital role in the global economy. Although this sector is expanding rapidly and provides abundance of new job opportunities, the risk of work-related illnesses, injuries, and fatalities is rising as a result of engagement of oil and gas employees in variety of tasks and duties (Witter et al, 2014).

According to recent research, oil and gas employees are at risk for ergonomic injuries caused by repetitive actions, awkward body positions, prolonged standing, bending, stooping, carrying heavy objects, turning valves, reaching overhead, and climbing (Aliyu et al.,2024).

Although WMSDs are a widespread problem that endangers the health and safety of oil and gas industry personnel, few studies have been undertaken in this area, particularly in Egypt. Furthermore, past researches had focused on the prevalence of WMSD, leaving a gap in our understanding of the involvement of risk factors in the development of WMSD among oil and gas workers. The current study was done to deal with this knowledge gap.

Aim of Work

To study the prevalence of musculoskeletal problems, to investigate its associations with risk factors and pinpoint its predictors among Egyptian Oil and Gas workers.

Materials and Methods

Study Design: It is an analytical cross-sectional study.

Place and duration of the study: The study was conducted at Egyptian oil and gas company (Engineering for petroleum and process industries –ENPPI); from November 2022 to December 2023.

Study Sample:

Simple random sampling was used to select 410 employees from a sampling frame of 3143 employees. Using Epi Info Stat-Calc software, version 7.2.4.0, the sample size was estimated with a 95% confidence interval, 5% precision, and a 47.7% prevalence of MSD symptoms based on a prior study among oil and gas workers (Allama et al., 2017). A sample size of 342 workers was initially estimated then the sample size was expanded to take into consideration any possible incomplete or missing data. Employees who have been employed for a year or more at various departments and divisions of ENPPI were included. Individuals who had a history of musculoskeletal issues prior to starting their current positions were excluded.

Study methods:

A questionnaire that was sent to the employees via email was used to gather data.

The questionnaire was divided into 4 sections. **Part one**: was used

to collect personal data: gender, age, weight, height. **Part two:** Job characteristics: job position, duration of employment in years, hours worked per day. **Part three:** The standardized Nordic questionnaire (Crawford, 2007) was used to determine the presence and absence of musculoskeletal complaints in various parts of the body in the previous 12 months in a respondent's neck, shoulders, elbows, upper back, wrists/hands, lower back, hips/thighs, knees, and ankles/feet. **Part four:** Questions to assess organizational, psychological, biomechanical, and environmental aspects of the workplace that may be linked to musculoskeletal problems.

Consent

Participants gave consent before data collection and were informed about the study's purpose and confidentiality of their information.

Ethical Approval

Two approvals were obtained before field work. An Ethical approval from the Ethical Committee at the Faculty of Medicine, Suez Canal University was obtained on March 29, 2022, (No #4835), and approval from ENPPI-Company before starting data collection.

Data Management

The collected data were analyzed using SPSS version 26. Frequencies and percentages were utilized for summarizing data. Chi square test was run out to examine associations between prevalence of MSP and selected demographic and work-related characteristics. Logistic regression analysis was performed to determine the independent predictors of musculoskeletal problems. The significance of the results was judged at p-value < 0.05.

Results

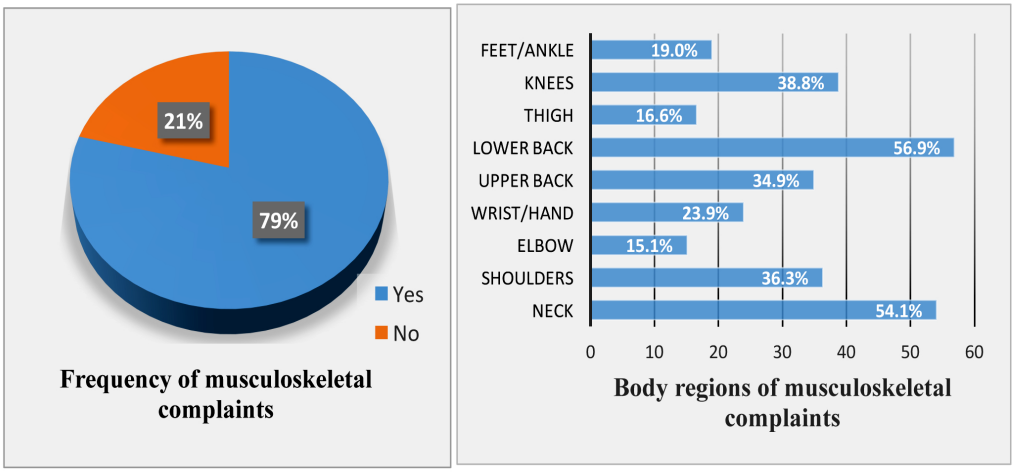

Figure 1: Frequency of musculoskeletal complaints among studied employees (No = 410).

Over the 12-month leading up to the study, 324 workers out of 410 workers (79.0 %) reported musculoskeletal complaint in at least one body region with the lower back, neck and knees being the most afflicted regions (56.9%, 54.1% and 38.8%, respectively). whereas, the elbows were the least frequently reported regions (15.1%) (Figure 1).

Table 1: Association between musculoskeletal complaints and the employees' characteristics.

Variables No. (%)		Total No = 410	Complaint No= 324	NO complaint No = 86	p-value
		No. (%)	No. (%)		
Gender	Male	351 (85.6)	269 (76.6)	82 (23.4)	0.004*
	Female	59 (14.4)	55 (93.2)	4 (6.8)	
Age (years)	< 40	203 (49.5)	151 (74.4)	52 (25.6)	0.022*
	40-60	207 (50.5)	173 (83.6)	34 (16.4)	
BMI (Kg/m^2)	Normal	87 (21.2)	61 (70.1)	26 (29.9)	0.064
	Overweight	181 (44.1)	149 (82.3)	32 (17.7)	
	Obese	142 (34.6)	114 (80.3)	28 (19.7)	
Working experience (years)	<15	173 (42.2)	121 (69.9)	52 (30.1)	<0.001*
	≥ 15	237 (57.8)	203 (85.7)	34 (14.3)	
Working hours / day	<10	182 (44.1)	159 (87.4)	23 (12.6)	<0.001*
	≥ 10	228 (55.9)	165 (72.4)	63 (27.6)	

*:Statistically significant at p <0.05

Table 1 showed that there was a statistically significant higher prevalence of musculoskeletal complaints among female workers (p = 0.004) , increasing age, work experience and working for less than 10 hours/day (p= 0.022, <0.001 and <0.001 respectively).

Table 2: Association between musculoskeletal complaints and presence of biomechanical and environmental risk factors .

Risk factors	Musculoskeletal complaints in the last 12 months			
	Total No = 410	Complaint No= 324	NO complaint No = 86	p-value
	No. (%)	No. (%)	No. (%)	
Biomechanical risk factors				
Sustained body position	348 (84.9)	286 (82.2)	62 (17.8)	**<0.001***
Twisting of trunk	104 (25.4)	86 (82.7)	18 (17.3)	0.288
Repetitive movements	284 (69.3)	245 (86.3)	39 (13.7)	**<0.001***
Bending	110 (26.8)	83 (75.5)	27 (24.5)	0.282
Exerting force with hands	54 (13.2)	39 (72.2)	15 (27.8)	0.188
Exposure to vibration	34 (8.3)	27 (79.4)	7 (20.6)	0.954
Environmental risk factors				
Insufficient lighting	328 (80.0)	252 (76.8)	76 (23.2)	**0.029***
Inappropriate furniture	305 (74.4)	230 (75.4)	75 (24.6)	**0.002***
Inadequate ventilation	269 (65.6)	192 (71.4)	77 (28.6)	**<0.001***
Temperature discomfort	286 (69.8)	215 (75.2)	71 (24.8)	**0.004***
Uncomfortable sound levels	255 (62.2)	187 (73.3)	68 (26.7)	**<0.001***

*:Statistically significant at p <0.05

Table 2 showed that the presence of musculoskeletal complaints among the studied participants were statistically significantly associated with biomechanical characteristics such as repetitive movements and sustained body posture. Moreover, the following documented environmental risk factors were significantly associated with the emergence of musculoskeletal complaints: improper furniture, insufficient lighting, inadequate ventilation, temperature discomfort, and uncomfortable sound levels.

Table 3: Association between the prevalence of musculoskeletal complaints and the presence of organizational and psychological risk factors .

Risk factors	Musculoskeletal complaints in the last 12 months			p-value
	Total No = 410	Complaint No= 324	NO complaint No = 86	
	No. (%)	No. (%)	No. (%)	
Organizational Risk Factors				
Inadequate rest breaks	233 (56.8)	191 (82.0)	42 (18.0)	0.092
Multitasking	228 (55.6)	200 (87.7)	28 (12.3)	**<0.001***
Department staff shortage	241 (58.8)	176 (73.0)	65 (27.0)	**<0.001***
Inadequate ergonomic training	297 (72.4)	249 (83.3)	48 (16.2)	**<0.001***
Psychological Risk Factors				
Continue work even they have pain	268 (65.4)	235 (87.7)	33 (12.3)	**<0.001***
Work under time pressure.	351 (85.6)	284 (80.9)	67 (19.1)	**0.022***
Work under pressure from leadership.	160 (39.0)	131 (81.9)	29 (18.1)	0.257
Lack of support from management or colleagues	25 (6.1)	22 (88.0)	3 (12.0)	0.255
Low job satisfaction	331 (80.7)	251 (75.8)	80 (24.2)	**0.001***
Lack of involvement in making decisions	277 (67.6)	210 (75.8)	67 (24.2)	**0.021***
Lack of job control	261 (63.7)	193 (73.9)	68 (26.1)	**0.001***

*: Statistically significant at $p < 0.05$

As shown in table 3, the prevalence of musculoskeletal complaint was significantly associated with multitasking, shortage of the department staff and inadequate ergonomic training. As regard psychological risk factors, musculoskeletal complains were significantly associated with continue working despite of having pain, work under time pressure, low job satisfaction, lack of involvement in making decisions and lack of job control.

Table 4: Logistic regression model of the predictors of musculoskeletal complaints among studied workers (No= 410).

	Sig.	OR	95% CI for OR	
			Lower	Upper
Gender	0.242	0.486	0.145	1.630
Age (years)	0.529	0.755	0.315	1.810
Working experience (years)	**0.014***	2.915	1.239	6.856
Working hours /day	0.211	0.651	0.332	1.276
Sustained body position	**0.029***	2.325	1.092	4.948
Repetitive movements	0.117	1.672	0.880	3.179
Insufficient lighting	0.987	1.008	0.393	2.585
Inadequate furniture	0.343	0.664	0.285	1.548
Inadequate ventilation	**0.007***	0.272	0.105	0.703
Temperature discomfort	0.410	1.443	0.603	3.450
Uncomfortable sound levels	0.557	0.807	0.394	1.651
Multitasking	0.199	1.517	0.803	2.866
Department staff shortage	0.266	0.686	0.354	1.332
Inadequate ergonomic training	0.374	1.324	0.713	2.459
Continue work even they have pain or injury	**0.006***	2.336	1.282	4.257
Work under time pressure.	0.852	0.928	0.423	2.038
Low job satisfaction	0.152	0.474	0.171	1.315
Lack of involvement in making decisions	0.526	1.255	0.621	2.535
Lack of job control	0.221	0.648	0.324	1.297
Constant	0.000	0.158		

OR: odds ratio CI: confidence interval *: Statistically significant at $p < 0.05$

In Table 4, multivariate analysis using a logistic regression model revealed that the main determinants of WMSDs among the studied sample of oil and gas workers were: working for 15 years or more (OR: 2.915, $p = 0.014$), sustained body position (OR: 0.25, $p = 0.029$), inadequate ventilation (OR: 0.007, $p = 0.018$), and continue work even they have pain or injury (OR: 1.282, $p = 0.006$).

Discussion

Given the nature of the oil and gas industry, employees carry out a diversity of tasks, some of which can lead to illnesses. These tasks put them at risk for physical, chemical, and ergonomic risks (Aliyu et al.,2024). This cross-sectional study was carried out between November 2022 and December 2023 among 410 workers in Egyptian oil and gas company (ENPPI). Musculoskeletal complaints were highly prevailed among the studied workers, with a rate of 79.0% (Figure1). This outcome is in line with the findings of a study conducted by Fan et al. (2024) among Chinese workers, as 73.2% reported musculoskeletal disorders in the past year. Likewise, Khoshakhlagh et al., (2022) disclosed that the prevalence of WMSDs among Iranian workers within the 12 months prior to the study was 71.3 %. Higher prevalence rate (88.8%) was reported by Norwegian oil workers (Omojunikanbi et al, 2022) and in China, the annual prevalence of WMSDs for oilfield workers was 90.5% (Wang et al., 2018). On the other hand, a previous Egyptian study done by Allama et al. (2017) among gaz field workers ; showed that only 47.7% of workers had regional musculoskeletal pain at least one MSD in the previous 6 months. The variations in case definitions utilized in the various research with respect to complaint duration or intensity may be the cause of this discrepancy in prevalence rates of musculoskeletal complaints among oil and gas workers. Additionally, the workers in various studies may have different work characteristics or demographics, and the actual tasks they completed may differ in quantity or quality depending on the research methodologies used.

According to this study's analysis of the particular body parts impacted by MSD, the studied workers had the highest prevalence of musculoskeletal problems in the lower back (56.9%), neck (54.1%), and knees (38.8%) (Figure 1). This clustering pattern aligned with previous studies conducted among oil workers in Egypt, China, and Nigeria whereas the lower back was the highest affected body regions (Allama et al., 2017; Wang et al., 2018; Omojunikanbi et al.,٢٠٢٢, respectively).

Age is indeed a major risk factor for work-related musculoskeletal disorders. Researches consistently displayed that musculoskeletal diseases are more common among senior workers (Omo-

junikanbi et al., 2022). In the current study, musculoskeletal complaints were significantly higher among those with older age (40- 60 years old) (Table 1). Similarly, numerous researches had documented an association between growing older and the occurrence of WMSDs (Okunribido et al., 2011, Park and Jeong, 2021; Fan et al., 2024). This can be explained by the fact that the biological structures of the body, particularly those pertaining to bone and muscle, deteriorate with age. This increases the likelihood of WMSDs because as people age, their muscular strength and connective tissues' functional capabilities decline (Jeffree et al., 2024). This finding, however, contradicts those who claimed that aging had no association with musculoskeletal issues (Aggarwal et al., 2013). The study population's relatively young age may be one reason for the difference findings, given that the individuals were most likely in their early twenties, an age range that is often unaffected by the degenerative processes linked to aging.

Employment characteristics, as increased years of experience were identified in the present study as significant risk factors for the development of WMSDs (Table1). In line with a Nigerian study by Omojunikanbi et al. (2022), WMSD and duration of work were found to be significantly associated. It can be explained by the fact that as job experience increases, chronic musculoskeletal tiredness may lead to cumulative tension on muscles and tendons, which in turn reduces blood flow to the relevant areas.

Studied female workers had a higher prevalence of MSDs compared to males (Table1). Female sex has been linked to an increased incidence of WMSD in previous studies (Castro et al., 2024; Fan et al.,2024). This was justified by the fact that women's muscles are weaker compared to men and that they may do two roles: housewives and workers (caregiving and household chores) (Demissie et al., 2024).

There was no significant relation between BMI and MSK complaints among the studied group (Table 1). These results are consistent with those of Aggarwal et al. (2013) and Bin Homaid et al. (2016). On the other hand, Borayek et al. (2011) from Egypt revealed that workers with high BMI had a significantly higher frequency of MSD complaints.

Repetitive motions and sustained

body positions were significantly associated with the presence of musculoskeletal complaints among the workers surveyed (Table 2). Any muscle group may eventually become fatigued from repetitive motions, which will lead to tension in other muscles while doing the task (Yang et al.,2023). In agreement with the current research findings for the ergonomics-related risk factors, several studies (Das et al., 2020; Yang et al., 2023) reported that sustained posture is significant risk factors for MSD symptoms. This is affirmed by other authors who also reported that this faulty posture influenced the musculoskeletal pain felt by workers (Dagne et al., 2020; Etana et al., 2021; Azmi and Aziz, 2022). An explanation for this could be that blood flow is decreased when muscles are kept in a fixed position without relaxing. In addition, prolonged use of the same posture increases the muscular load and activity surrounding the facet joint, resulting in joint compression and influencing musculoskeletal symptoms (Demissie et al., 2024)

Other risk factors as bending, using vibration tools and exerting force with hands have been repeatedly implicated in prior studies (Fan et al., 2024). However, the present study found no significant differences in these ergonomic risk factors (Table 2).

The working environment may affect operators' productivity and result in WMSDs. The prevalence of musculoskeletal problems among the studied workers was significantly associated with poor ventilation, lighting, and sound level (Table 2). This was in consistent with the research done in India that shown that noise and light have an impact on workers' MSDs (Satheeshkumar and Krishnakumar, 2020). Additionally, the prevalence of WMSD was significantly associated with improper furnishings. Our findings were supported by other authors who have confirmed that there is a correlation between WMSDs and poorly adapted chairs/desks (Okezue et al., 2020).

There was a significant association between the occurrence of WMSDs and working in thermally discomfort environment. Similar findings were also detected by other investigators from China (Yong et al. 2020; Yang et al., 2023).

As for labor organization factors, department staff shortages, multitasking and inadequate ergonomic training were identified as risk factors

for the development of WMSDs. When departments are short-staffed, employees frequently take on extra ad hoc work and reduce their downtime. Working for long hours and inadequate rest, will render the body from recuperating completely from high-intensity labor, leaving employees exhausted, which increases the likelihood of WMSDs (Das et al., 2020).

The majority of the studied workers, who had never attended ergonomic training (83.3%), were WMSD-afflicted (Table 3). Sikiru and Hanifa (2010) have established a correlation between the incidence of WMSDs and ergonomic training; they detected a significant association between knowledge of ergonomics and incident of MSDs. According to a research done by Demissie et al., (2022) who found that respondents who did not receive ergonomics training were 5.4 times more likely to have WMSDs than those who did. Conversely, Bin Homaid et al. (2016) did not find any correlation between musculoskeletal complaints and a lack of educational training. This can be clarified by that untrained individuals might fail to follow established protocols and work practices because they lack the information and essential skills required to implement practical precautions against musculoskeletal disorders.

The significant impact of work-related psychosocial risk factors on WMSDs has been emphasized by a number of studies. Aggarwal et al. (2013) revealed that high perceived psychological demands were key risk variables of WMSDs. There was a significant association between psychosocial risk factors, such as a lack of job control and decision-making involvement, and musculoskeletal complaints among the studied group of workers (Table 3). This is consistent with Singh et al. (2022) who mentioned that low job control was significantly related with WMSDs. By raising physical stress or biomechanical load, psychosocial stresses may raise the risk of MSDs (Hauke et al., 2011; Fan et al., 2024).

The current results were in line with other researches (Tegenu et al., 2021; Ghahremani et al., 2024), who found that WMSDs were significantly higher among dissatisfied workers than among satisfied ones. This could be explained that workers who were dissatisfied with their working conditions may

experience stress, which causes muscle tension, which further exacerbates the development of pain. On the other hand, satisfied workers may be better able to manage job demands, control imbalance, and reduce their risk of WMSDs.

According to the results of the multivariate analysis (Table 4), the likelihood of developing WMSDs was 2.915 times greater among workers who had a long work duration compared to those with less work experience. This may be due to the fact that longer job tenure exposes people to more risk factors than shorter ones. Therefore, cumulative trauma or recurrent strains that progressively develop as a result of overuse are the nature of work-related musculoskeletal disorders (Yang et al., 2023).

It is worth noting that continuing to work while feeling discomfort or pain was found to be a predictor for WMSDs. Those who continue working despite experiencing some pain or discomfort have a 2.23-fold higher chance of developing WMSD. Similarly, a study conducted in Nigeria found that WMSD was significantly predicted by continuing to work when experiencing pain or discomfort (OR = 2.23) (Omojunikanbi et al., 2022).

Sustained body position significantly predicts WMSDs among the studied workers, as sustained body postures enhance the likelihood of MSD by more than two times (Table 4). This finding is comparable with Shanbhag et al. (2024), who found that participants who reported working in the same position had a 4.854 higher risk of acquiring WRMSDs than more active participants. This sustained posture causes muscle co-contraction, resulting in increased strain on muscles, tendons, and joints, producing pain (Goradia and Shimpi, 2023).

Poor ventilation was a significant predictor of musculoskeletal complaints among the studied workers (Table 4). This is concomitant with the result of Castro et al.,2024 who revealed that inadequate ventilation was found to be a significant predictor ($p = 0.003$) of musculoskeletal complaints

Conclusion

Workers in the oil and gas industry frequently experience work-related musculoskeletal complaints whereas 79.0% of the participants reported having a musculoskeletal issue in one or more body areas, with lower back

(56.9%) and neck (54.1%) being the most frequently impacted areas. The predictors of this high prevalence found in the current study were long tenure, sustained body position, poor ventilation, and continuing to work despite the presence of pain.

Recommendations

The current study suggests that, it is essential to create preventive measures and interventions to preserve the health of oil and gas employees and guarantee a safe working environment as implementing ergonomic training programs, modifying workstations, promoting frequent breaks, introducing wellness programs. To lessen the impact of MSD on such workers, psychosocial factors should be taken into account in MSD prevention initiatives. Future researches should be conducted to ascertain the causal role of the risk factors in the development of WMSDs. Furthermore, research into the effectiveness of these interventions in reducing musculoskeletal pain should be addressed.

Study limitations

Although the current study offers insightful information, it is crucial to acknowledge its limitations, particularly the possibility of recall bias with self-reported data. The use of a single company may limit the generalization of the findings. Furthermore, causality cannot be established by the cross-sectional design; a prospective longitudinal design is required to gain a deeper understanding of the causal relationships between the variables.

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Conflict of Interest

All authors have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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