



## Knowledge and Attitude of Parents toward Pediatric Lumbar Puncture and its Relationship with Demographical Factors in Al-Ahsa, Saudi Arabia

Yameen Almatawah<sup>1</sup>, Fadi Busaleh<sup>2</sup>, Ahmed Alkhars<sup>3</sup>✉, Wejdan Almarzooq<sup>3</sup>, Mohammed Almarzooq<sup>3</sup>, Abdullah Alkhars<sup>3</sup>, Abdulhakim Almarzooq<sup>3</sup>, Alreem Albaqshi<sup>3</sup>, Fatimah Alkhars<sup>4</sup>

<sup>1</sup>Pediatric Infectious Disease Consultant, King Fahad Hospital, Al-Ahsa, Saudi Arabia

<sup>2</sup>Pediatric Resident, Maternity & Childhood Hospital, Al-Ahsa, Saudi Arabia

<sup>3</sup>Medical Student, King Faisal University, Al-Ahsa, Saudi Arabia

<sup>4</sup>Medical Resident, Prince Saud bin Jalawi Hospital, Al-Ahsa, Saudi Arabia

### ✉Corresponding Author:

Ahmed Alkhars

Al-Ahsa, Eastern Province, Saudi Arabia

P.O Box: 4917, Zip: 31982

E-mail: Azamkx@gmail.com

Phone: 00966558996684

### Article History

Received: 07 June 2020

Reviewed: 08/June/2020 to 14/July/2020

Accepted: 15 July 2020

E-publication: 21 July 2020

P-Publication: September - October 2020

### Citation

Yameen Almatawah, Fadi Busaleh, Ahmed Alkhars, Wejdan Almarzooq, Mohammed Almarzooq, Abdullah Alkhars, Abdulhakim Almarzooq, Alreem Albaqshi, Fatimah Alkhars. Knowledge and Attitude of Parents toward Pediatric Lumbar Puncture and its Relationship with Demographical Factors in Al-Ahsa, Saudi Arabia. *Medical Science*, 2020, 24(105), 2883-2892

### Publication License



This work is licensed under a Creative Commons Attribution 4.0 International License.

## General Note

 Article is recommended to print as color digital version in recycled paper.

## ABSTRACT

*Introduction:* Lumbar puncture (LP) or spinal tap is a procedure where a sample of the cerebrospinal fluid is extracted utilizing a needle. Despite the fact, LP is safe and has therapeutic and diagnostic value; many parents refuse to give consent for performing the procedure on their children which hinder the process of diagnosis and treatment. The purpose of this study is to describe the level of knowledge and attitudes toward LP of parents in AlAhsa and its correlation with various factors like age, ethnicity, level of education, socio-economical state. *Methods:* This is a cross-sectional study that evaluated the knowledge and attitude of parents of LP and its correlation with demographical factors in AlAhsa, Saudi Arabia. Data were obtained through an online questionnaire. Basic statistical parameters were calculated including frequency mean and proportions. Independent T-test and ANOVA test were used to test for association. *Results:* A total of 466 responses have been included in the study, of which it showed that only 12.6% of the participant refused to give consent to LP when needed. Only 8.40% had a high level of knowledge. However, 61.1% of respondents were categorized with high level of attitude. A significant association was observed between knowledge level groups and total attitude scores towards LP, the higher the total knowledge scores, the better the total attitude scores towards LP ( $p < 0.001$ ). *Conclusion:* Despite the lack of knowledge and the misconception of LP, parents' attitude showed high levels of acceptance. Further community education regarding the importance of LP and the safety of procedures is highly recommended.

**Keywords:** Pediatric, Lumbar Puncture, Knowledge, Attitude, Epidemiology.

## 1. INTRODUCTION

Lumbar puncture (LP) or spinal tap is a procedure where a sample of the cerebrospinal fluid is extracted utilizing a needle. Commonly used for the diagnosis of meningitis, encephalitis, subarachnoid hemorrhage, and other conditions. LP can also be therapeutic in conditions like pseudo tumor cerebri (Shlamovitz & Shah, 2020). LP is a safe procedure when performed by an expert, however, there are some potential complications like headache, infection, and bleeding. Other complications like paraplegia, dysesthesia and cerebral herniation are extremely rare and seldom seen (Shlamovitz & Shah, 2020; Rebecca & Lehman, 2016; Schneider, 2013). Despite the fact, LP is safe and has therapeutic and diagnostic value, many parents refuse to give consent for performing the procedure on their children which hinder the process of diagnosis and treatment.

Various studies have shown that the refusal rate can be as high as 80% in Kuwait, 62% in Iran, 44% in the UAE, 24.7% in Malaysia, and 7% in Denmark drooping to 5% in the United States. In Saudi Arabia, a recent study has shown a refusal rate of about 36% (Narchi et al., 2013; Ahmed et al., 2019). Different reasons have been identified for refusal including fear of complications like paralysis, finding the procedure to be unnecessary and distrusting the motive for requesting it (Narchi et al., 2013; Deng et al., 1994). Ethnicity, level of knowledge, level of education and counseling with the doctor has been shown to significantly correlate with the parent attitude toward LP. This negative attitude of parents by rejecting LP for children results in many negative impacts like the blind administration of empirical antibiotics which may contribute to bacterial resistance. This burdens the health care system by prolonging the hospital stay and elevating the hospitalization costs (Wan Sulaiman et al., 2018). Realizing how impactful this topic is, we find it important to enrich the literature with more information about this topic to help understand the issue and open paths of a solution to it. In this study, we aim to assess the knowledge and attitude of parents from Al-Ahsa toward LP and their relation to multiple factors like age, ethnicity, level of education, socio-economical state.

## 2. METHODOLOGY

### Study Design and Population

The study was a cross-sectional study targeting parents living in Al-Ahsa, Saudi Arabia and was undertaken from February 2020 to May 2020.

### Sampling

The used sampling technique was convenient random sampling where an online questionnaire was disseminated on social media and parents were invited to fill it up. Sample size was calculated using the formula  $n = \frac{z^2pq}{d^2}$ . With confidence level of 95%, estimated proportion of 50% and 5% level of precision appropriate sample size was calculated to be 385. However, more participants were included to ensure sufficiency and accuracy of results.

### Data collecting

An online survey was created on Google form was created and utilized for data collection. Data were obtained from a self-administered questionnaire where parents gave consent to participate in the study before starting to fill the questionnaire.

### Study Tool

The questionnaire was composed of four parts, the first surveyed demographical and socio-economic data like age, gender, nationality, level of education and monthly income. The second asked about the parents' opinion and prior experience toward the LP as well as fear of needles. The third section assessed the knowledge of parents about LP, there were 18 questions about the nature of the procedure, the indications and the complications. To assess the parents' knowledge about LP, a LP 'knowledge score' was created. One point was given for every correct choice and zero for the wrong choice. Those who scored less than 50% were considered as having poor knowledge while those with a score of 50%-75% were considered moderately informed and those who scored above 75% were considered well informed. The last section asked about the attitude of parents toward LP, it contained 9 questions with Likert scale, where a score of 1 – 5 was given to each question. A total score of less than 50% was considered to be negative attitude, a score of 50% - 75% moderate, a score above 75% positive. The questionnaire was pre-validated by another study (Wan Sulaiman et al., 2018) and was translated to Arabic. The Arabic version was presented to 3 experts in the field and the translation was approved after grammatic and linguistic modification.

### Statistical Analysis

The data processing was done using Statistical Package for the Social Sciences, SPSS 23rd version. Basic statistical parameters were generated and included frequency, mean and proportions. Independent T-test was used to test the association between the knowledge and attitude scores and age, gender, ethnicity, level of education socio-economical state and refusal or acceptance of LP, ANOVA test was used for variables with more than 2 groups. ANOVA test was also used to assess the association between knowledge group and attitude score. A p-value of  $\leq 0.05$  was considered significant. Incomplete questioners were excluded from the analysis.

## 3. RESULTS

A total of 497 responses have been received, of which 466 were analyzed, the other was excluded due to incomplete data. The socio-demographic characteristics of the respondents have been shown in Table 1. The majority of which were Saudi at 98.9% and females account for the largest stake as well at 62.2% (290). Most of the respondents' age falls in the range of 35 to 50 years old. 69.7% of the respondents had Bachelor/Diploma education. The monthly income of most respondents 36% (168) is between 10000 – 20000 SR. The questionnaires showed that about 48.1% (224) of respondents were aware of LP, but only 5.2% of them had experienced LP themselves and about 27% have relatives with LP past experience. Table 2 shows the frequency of responses regarding knowledge of LP. Table 3 shows the frequency of response regarding attitude towards LP. It was revealed that only 12.6% of the participant refused giving consent to LP when needed. Figure 1 shows the level of knowledge based on the 18 knowledge questions and the respondents were categorized into three groups, high-level knowledge of LP with 8.40%, moderate level knowledge with 29.20% and low-level knowledge with 62.40%. Table 4 shows that this study also found a significant association between total knowledge scores and total attitude scores towards LP. The higher the total knowledge scores, the better the total attitude scores towards LP ( $p < 0.001$ ). Educational levels of the respondents were significantly associated with both knowledge and attitude scores. The respondents with a master's or Ph.D. had higher knowledge score than School and Bachelor/Diploma ( $p < 0.001$ ). Master's or Ph.D. and Bachelor/Diploma had higher attitude scores towards LP compared to school level ( $p = 0.006$ ). In regard to the income association with the knowledge score, the study shows a clear correlation. People with monthly income higher than 20000 SR have significantly higher knowledge score compared to those who make 10000 SR or less ( $p = 0.001$ ). Besides, respondents who were aware of LP had significantly higher knowledge and attitude scores regarding LP ( $p < 0.001$ ). Also, respondents who underwent LP previously have a higher knowledge score ( $p = 0.048$ ). In terms of attitude towards LP, those who have a family member or a friend with a past LP experience have higher attitudes score ( $p = 0.001$ ). Table 5 shows the association

between fear of needles on the back and the attitude of LP. Respondents who were afraid of needles on the back had significantly lower scores than those who were not ( $p < 0.001$ ).

**Table 1**

Socio-demographical Characteristics of Respondents. (n = 466)

Socio-demographical Characteristics of Respondents.		N	%
Parent	Father	176	37.8
	Mother	290	62.2
Age	18 – 25	65	13.9
	25 – 35	117	25.1
	35 – 50	218	46.8
	More than 50	66	14.2
Nationality	Saudi	461	98.9
	Non-Saudi	5	1.1
Educational Level	School	110	23.6
	Bachelor / Diploma	325	69.7
	Master / PhD	31	6.7
Monthly Income	Less than 5000 SR	68	14.6
	5000 - 10000 SR	158	33.9
	10000 - 20000 SR	168	36
	20000 - 30000 SR	38	8.2
	More than 30000 SR	34	7.3

**Table 2**

Frequency Distribution of Responses Regarding Knowledge of Lumbar Puncture (n = 466)

No	Knowledge Question	Yes	No	I don't Know	Correct Response N (%)	Incorrect Response N (%)
1	In your opinion, which photo shows the lumbar puncture (spinal tap) procedure?	N/A	N/A	N/A	371 (79.6%)	95 (20.4%)
2	In your opinion, which part of the spinal cord that the needle inserted?	N/A	N/A	N/A	338 (72.5%)	128 (27.5%)
3	In your opinion, which photo showed the right lumbar puncture (spinal tap) procedure?	N/A	N/A	N/A	250 (53.6%)	216 (46.4%)
4	Lumbar puncture (spinal tap) is a procedure in which a needle is inserted at the lower back of spinal column to withdraw the cerebrospinal fluid (Fluid that originates from brain and spinal cord).	260 (55.8%)	20 (4.3%)	186 (39.9%)	260 (55.8%)	206 (44.2%)
5	Doctors will use analgesics and sedatives during lumbar puncture (spinal tap). This will make this procedure relatively painless.	259 (55.6%)	44 (9.4%)	163 (35%)	259 (55.6%)	207 (44.4%)
6	This procedure will take only approximately 10 minutes in the ward.	217 (46.6%)	61 (13.1%)	188 (40.3%)	217 (46.6%)	249 (53.4%)

7	The patient does not need to be in the operation theatre. Doctors do lumbar puncture (spinal tap) to diagnose bacterial, viral and fungal infections of the brains and spinal cords such as meningitis and encephalitis disease.	246 (52.8%)	25 (5.4%)	195 (41.8%)	246 (52.8%)	220 (47.2%)
8	Doctors do lumbar puncture (spinal tap) to give spinal anesthetic.	113 (24.2%)	87 (18.7%)	266 (57.1%)	113 (24.2%)	353 (75.8%)
9	Doctors do lumbar puncture (spinal tap) as therapeutic method for some diseases such as cancer by giving chemotherapy into the cerebrospinal fluid.	124 (26.6%)	83 (17.8%)	259 (55.6%)	124 (26.6%)	342 (73.4)
10	Lumbar puncture (spinal tap) can cause severe back pain.	159 (34.1%)	78 (16.7%)	229 (49.2%)	78 (16.7%)	388 (83.3%)
11	After lumbar puncture, the patient may have urinary continence.	47 (10.1%)	108 (23.2%)	311 (66.7%)	108 (23.2%)	358 (76.8%)
12	After lumbar puncture (spinal tap), the patient may have erectile dysfunction	45 (9.6%)	81 (17.4%)	340 (73%)	81 (17.4%)	385 (82.6%)
13	A CT scan will be done before carrying out lumbar puncture (spinal tap) if any contraindication is suspected.	170 (36.5%)	27 (5.8%)	269 (57.7%)	170 (36.5%)	296 (63.5%)
14	Doctors can use CT scan or MRI instead of lumbar puncture (spinal tap) for accurate diagnosis.	61 (13.1%)	126 (27%)	279 (59.9%)	126 (27%)	340 (73%)
15	Lumbar puncture (spinal tap) causes severe complications.	131 (28.1%)	89 (19.1%)	246 (52.8%)	89 (19.1%)	377 (80.9%)
16	Lumbar puncture (spinal tap) is a low risk procedure and relatively safe.	143 (30.7%)	80 (17.2%)	243 (52.1%)	143 (30.7%)	323 (69.3%)
17	Commonest complication for lumbar puncture (spinal tap) is post puncture headache.	140 (30%)	28 (6%)	298 (64%)	140 (30%)	326 (70%)
18	Post puncture headache can be prevented by lying flat for 6 hours after the procedure.	126 (27%)	16 (3.5%)	324 (69.5%)	126 (27%)	340 (73%)

**Table 3**

Frequency Distribution of responses regarding attitude towards lumbar puncture among responders (n = 466)

No	Attitude Questions	Strongly Agree (%)	Agree (%)	Neutral (%)	Disagree (%)	Strongly Disagree (%)
1	Lumbar puncture (spinal tap) is not safe and should be avoided.	64 (13.7%)	32 (6.9%)	177 (38%)	67 (14.4%)	126 (27%)
2	In your opinion, society doesn't know the importance of lumbar puncture (spinal tap) as diagnostic method	189 (40.6%)	94 (20.2%)	143 (30.7%)	17 (3.6%)	23 (4.9%)
3	Society doesn't need more education about lumbar puncture	337 (72.3%)	43 (9.2%)	61 (13.1%)	10 (2.2%)	15 (3.2%)

(spinal tap).

4	If a doctor tells me that I need lumbar puncture (spinal tap), I prefer to be discharged at my own risk.	62 (13.3%)	39 (8.4%)	165 (35.4%)	58 (12.4%)	142 (30.5%)
5	If a doctor tells me that I need lumbar puncture (spinal tap), I want him or her to explain the procedure.	365 (78.3%)	27 (5.8%)	55 (11.8%)	5 (1.1%)	14 (3%)
6	Informed consent to carry out lumbar puncture (spinal tap) should be obtained from patients or their first-degree relatives.	330 (70.8%)	45 (9.7%)	67 (14.4%)	9 (1.9%)	15 (3.2%)
7	If a doctor said you should proceed with lumbar puncture (spinal tap) to diagnose your disease, you will agree by signing the consent letter.	185 (39.7%)	79 (17%)	143 (30.7%)	22 (4.7%)	37 (7.9%)
8	I rather undergo other treatment for a long time than diagnosing my disease by carrying out lumbar puncture (spinal tap).	85 (18.2%)	51 (11%)	180 (38.6%)	60 (12.9%)	90 (19.3%)
9	I would refuse to do lumbar puncture (spinal tap) due to my religious belief as my elders don't allow me to do so.	37 (7.9%)	26 (5.6%)	111 (23.8%)	60 (12.9%)	232 (49.8%)

**Table 4**

The Knowledge Level Groups Associated with Total Attitude Scores Towards Lumbar Puncture

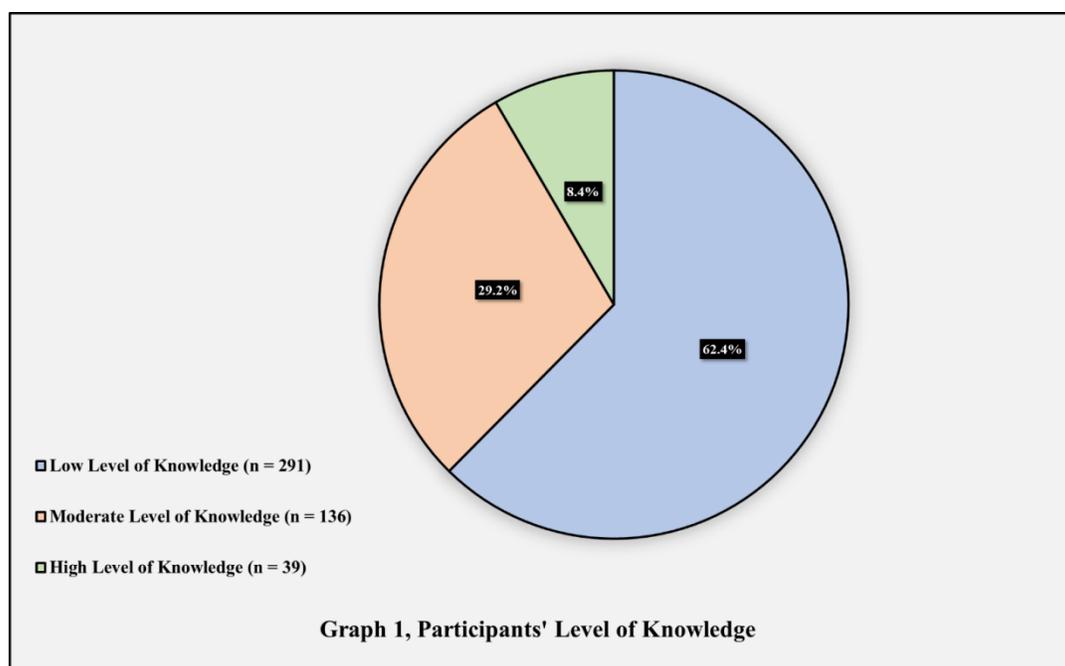
Level of Knowledge Group	N	Total Attitude score of LP Median	p-value
Low Level of Knowledge	291	34	< 0.001*
Moderate Level of Knowledge	136	36	
High Level of Knowledge	39	40	

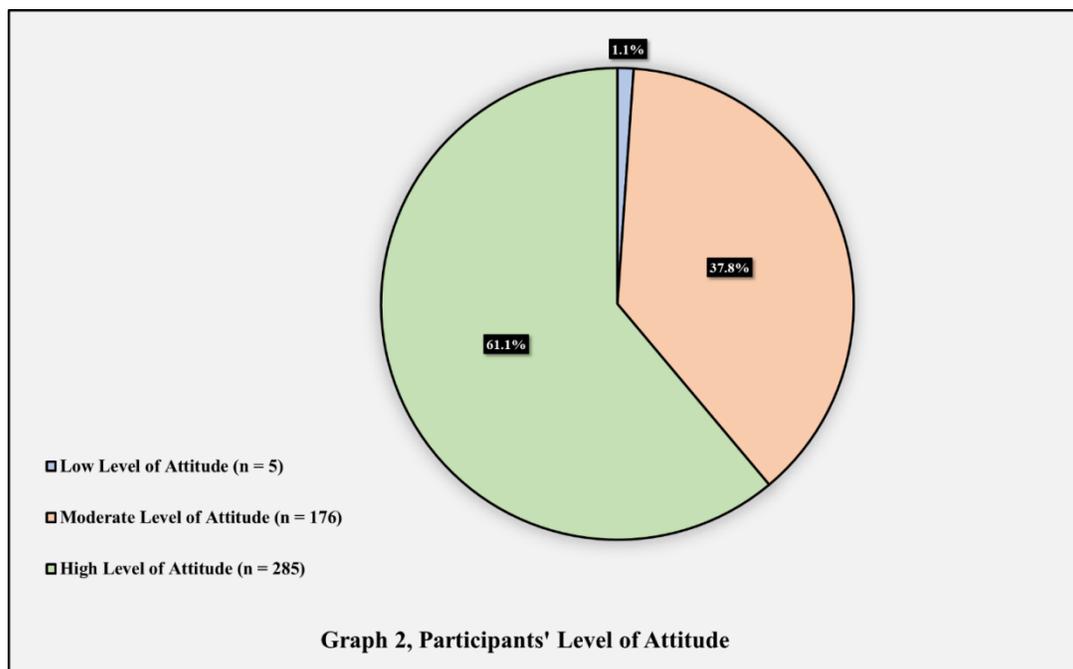
**Table 5**

The Association Between Socio-Demographical Factors with Total Score of Knowledge and Attitude Toward LP

Variable	N	Total Knowledge score of LP Median	p-value	Total Attitude score of LP Median	p-value
Parent (n = 466)			0.234		0.884
Father	176	7		35	
Mother	290	7		35	
Age (n = 466)			0.14		0.75
18 - 25	65	8		36	
25 - 35	117	6		35	
35 - 50	218	7		35	
More than 50	66	7.5		35	
Nationality (n = 466)			0.557		0.728
Saudi	461	7		35	

Non-Saudi	5	4		36
Educational Level (n = 466)			< 0.001*	0.006*
School	110	6		33.5
Bachelor / Diploma	325	7		35
Master / PhD	31	11		37
Monthly Income (n = 466)			0.001*	0.074
Less than 5000 SR	68	6		34
5000 - 10000 SR	158	6.5		35
10000 - 20000 SR	168	7		36
20000 - 30000 SR	38	8		37
More than 30000 SR	34	9.5		35.5
Heard about lumbar puncture before (n = 466)			< 0.001*	< 0.001*
Yes	224	9		37
No	242	5		33
Experienced a lumbar puncture (n = 260)			0.048*	0.804
Yes	24	10.5		37.5
No	236	8		36
Family member/ relatives/ friends experienced lumbar puncture (n = 259)			0.267	0.001*
Yes	121	9		37
No	138	7		36
Needle Phobia on hand (n = 260)			0.021*	0.053
Yes	215	8		36
No	45	10		39
Needle phobia on the back (n = 466)			0.121	< 0.001*
Yes	102	7		33
No	364	7		36





#### 4. DISCUSSION

All parents are naturally bound to seek the benefit for their children, however, their decision to consent for medical procedures for their children like LP can be influenced negatively by their opinion which is shaped by a variety of factors including religion, social and cultural values, as well as illiteracy and poverty (Jafarey & Farooqui, 2005).

Despite the fact, LP is a common effective procedure that is essential to make the diagnosis of some central nervous system diseases, the rejection for it is still a universal problem (Alwahbi et al., 2018; Qidwai et al., 2002; He et al., 2016). Previous studies have shown a refusal rate of 80% in Kuwait, 62% in Iran, 44% in the UAE, 24.7% in Malaysia, and 7% in Denmark dropping to 5% in the United States. A recent study in Saudi Arabia revealed a refusal rate of 36%. Compared to this study which showed only 12.6% refusal to LP consent when needed (Narchi et al., 2013; Ahmed et al., 2019).

Different reasons for LP refusal have been identified in the literature, this include fear of complications like paralysis and back pain. Mental retardation, trauma to the spinal cord and death were also among the complication perceived by public (Narchi et al., 2013; Deng et al., 1994; Wong et al., 2010). This may not be the case in this study, as only 28.1% of people did think LP can cause severe complications. In this study, the overall attitude toward LP was high in 61.10% of the participants, although only 48.1% of participants were aware of LP and only 8.40% had high-level knowledge of LP. It was also noticed that the higher the parent knowledge about LP, the better the attitude towards LP, which is consistent with Borhani Haghghi et al. finding. They stated that 90% of participants had poor knowledge of LP which was associated with the negative attitude towards LP. A similar finding was observed by Wan Sulaiman et al. (Wan Sulaiman et al., 2018; Haghghi et al., 2009). This phenomenon of a better attitude in people with better knowledge was observed in other studies about diabetes and stroke as well (Rosamond et al., 2007; Pereira et al., 2012). Cutler et al. have concluded in his research that investing in health education is worthwhile and can significantly improve population health after finding a strong relationship between education and health-related issues. Higher monthly income was also significantly associated with a higher level of knowledge which is not consistent with Aldayel et al. who reported no association between income and LP knowledge (Aldayel et al., 2019) Fear of needles, specifically on the back, is another factor that was found to significantly affected parents' attitude towards LP. These findings support those of earlier studies by Wan Sulaiman et al. (2018) and Aldayel et al. (2019).

Unfortunately, avoiding medical care is a consequence of needle phobia (Qidwai et al., 2002) which may affect parents' attitude towards an indicated procedure for their children as well. Limitations of this study may include that it is covering only the region of Al-Ahsa, and its findings cannot be generalized to other regions in Saudi Arabia due to the differences in cultures and beliefs. Also, the self-filled questionnaire may affect data accuracy and more questions are needed to assess further factors affecting LP knowledge and attitudes.

## 5. CONCLUSION

This study addressed some of the factors affecting parent's knowledge and attitudes towards LP in Al-Ahsa, Saudi Arabia. Our findings reflect a high level of parental attitudes towards LP despite the overall moderate level of knowledge. Further community education regarding the importance of LP and the safety of procedures are highly recommended. More studies are needed to correlate our results with other regions of Saudi Arabia.

### Acknowledgment

The authors acknowledge the Science Research Committee of King Fahad Medical City for protocol approval and all the participants in this study.

### Authors' contribution

Yameen Almatawah & Fadi Busaleh: Research conceptualization and manuscript revision.

Ahmed Alkhars: Study design and data analysis.

Wejdan Almarzooq, Mohammed Almarzooq & Fatimah Alkhars: Manuscript writing.

Abdullah Alkhars, Abdulhakim Almarzooq & Alreem Albaqshi: Data collecting.

### Funding

This research received no external funding.

### Conflicts of interest

The authors declare no conflict of interest.

### Informed consent

Informed consent was obtained from all individuals participants included in this study.

### Ethical approval

The study was approved by the medical ethics committee of King Fahad Medical City, Riyadh (Code: 20-228E).

### Data and materials availability

All data associated with this study are present in the paper.

## REFERENCES AND NOTES

1. Ahmed M, Ejaz M S, Jahangeer A, et al. Frequency and Associated Factors of Parental Refusal to Perform Lumbar Puncture in Children with Suspected Central Nervous System Infection: A Cross-sectional Study. *Cureus*, 2019, 11(9): e5653.
2. Aldayel A, Alharbi M, Almasri M, Alkhonezan S. Public knowledge and attitude toward lumbar puncture among adults in Riyadh, Saudi Arabia: A cross-sectional study. *SAGE Open Medicine*. 2019;7:1-9
3. Alwahbi ZM, Alzahrani AA, Alqhtani MM, Asiri WI, Assiri MA: Evaluation of Saudi Arabian parent's attitude towards lumbar puncture in their children for diagnosis of meningitis. *Egypt J Hosp Med*. 2018, 70:1582-1582.
4. Deng C, Zulkifli H, Azizi B. Parents' views of lumbar puncture in children with febrile seizures. *Med J Malaysia*. 1994;49:263-268.
5. Haghighi B, et al. Knowledge and attitudes of Iranian patients with regard to lumbar puncture. *Neuroscience (Riyadh)*. 2009;14(4):360-363.
6. He T, Kaplan S, Kamboj M, Tang YW: Laboratory diagnosis of central nervous system infection. *Curr Infect Dis Rep*. 2016, 18:35.
7. Jafarey AM, Farooqui A: Informed consent in the Pakistani milieu: the physician's perspective. *J Med Ethics*. 2005, 31:93-6.
8. Narchi H, Ghatasheh G, Hassani N, Reyami L, Khan Q: Comparison of underlying factors behind parental refusal or consent for lumbar puncture. *World J Pediatr*. 2013, 9:336-41.
9. Pereira DA, da Silva Campos Costa NM, Sousa ALL, Jardim PCBV, de Oliveira Zanini CR. The effect of educational intervention on the disease knowledge of diabetes mellitus patients. *Rev Lat Am Enfermagem*. 2012;20(3):478-485
10. Qidwai W, Qureshi H, Azam I, Ali SS, Ayub S: Perception of bioethics among general practitioners in Karachi, Pakistan. *Pak J Med Sci*. 2002, 18:221-6.

11. Rebecca K., Lehman NFS. Chapter 590. In: Nelson Textbook of Pediatrics. 20th ed: Philadelphia: Elsevier, Inc; 2016:2791.e1–2802.e1.
12. Rosamond W, Flegal K, Friday G, et al. Heart disease and stroke statistics–2007 update: a report from the American Heart Association statistics committee and stroke statistics subcommittee. *Circulation*. 2007;115(5):e69–e171
13. Schneider VF. Chapter 15. Essential Clinical Procedures. 3th ed. Philadelphia: Saunders; 2013:146–155.
14. Shlamovitz, G. and Shah, N. (2020). Lumbar Puncture: Background, Indications, Contraindications. [online] Emedicine.medscape.com. Available at: <https://emedicine.medscape.com/article/80773-overview#a1> [Accessed 13 Feb. 2020].
15. Wan Sulaiman, W., Muhamad Saliluddin, S., Ong, Y., MohdSazly Lim, S., Inche Mat, L., Hoo, F., Vasudevan, R., Ching, S., Basri, H. and Mohamed, M. A cross sectional study assessing the knowledge and attitudes towards lumbar puncture among the staff of a public university in Malaysia. *Clinical Epidemiology and Global Health*, 2018, 6(1), pp.29-33.
16. Wong SLJ, Yeoh AAC, Ooi TC, Lye. Parents View of Lumber Puncture in Children. *MJPCH*, 2010 (Dec); 16; Supplementary 2.