

Original Article

Public acceptability of lumbar puncture in the diagnosis of Alzheimer's disease: a questionnaire-based single center study in China

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Abstract: Aim: To investigate public acceptability of lumbar puncture in the diagnosis of Alzheimer's disease and to find out the factors influencing patient decision. Methods: We administered a questionnaire to participants who were native to Xi'an using the "Sojump" application. Participants were required to answer the questionnaire on their cell phones following the instructions. The questions of the questionnaire were divided into four categories, including demographic data, awareness of lumbar puncture, attitudes toward lumbar puncture for the diagnosis of Alzheimer's disease, and reasons for negative attitude. Logistic regression was used to analyze the factors influencing the attitude toward lumbar puncture testing. Results: A total of 1050 valid questionnaires were collected, including 403 (38.4%) from non-medical personnel and 647 (61.6%) from medical personnel. Among them, 35.7% of the participants knew about lumbar puncture examinations. Regarding the attitude, 862 participants (82.1%) had a positive attitude toward lumbar puncture in the diagnosis of Alzheimer's disease, and 508 (58.9%) of them considered lumbar puncture to be helpful in confirming the diagnosis. Multivariate analysis revealed that factors associated with a positive attitude in the non-medical group included age (OR=0.963, P=0.003, 95% CI: 0.939-0.987), education level (OR=2.073, P=0.037, 95% CI: 1.044-4.114), monthly income (OR=1.340, P=0.031, 95% CI: 1.028-1.748), and type of occupation (OR=1.569, P=0.038, 95% CI: 1.026-2.400). Factors associated with a positive attitude in the medical group included place of residence (OR=9.182, P=0.036, 95% CI: 1.151-73.238), monthly income (OR=4.008, P=0.002, 95% CI: 1.689-9.511), and hospital level (OR=38.311, P < 0.001, 95% CI: 14.323-102.478). Conclusions: More than 80% of the public has a positive attitude towards lumbar puncture in the diagnosis of Alzheimer's disease, suggesting high acceptability. However, the attitude toward lumbar puncture is depend on age, education level, economic status, and type of occupation.

Keywords: Alzheimer's disease, diagnosis, biomarkers, lumbar puncture, questionnaires

Introduction

The rising elderly population has led to an increase in the prevalence and incidence of Alzheimer's disease (AD), which presents a great challenge to both families and society [1-5]. Because there is currently no cure for AD, it is important for people to have the access for early evaluation and timely diagnosis. As previously reported, approximately 70-80% of AD patients in China are not diagnosed and treated, largely due to economic hardship and lack of awareness of the disease [6]. Therefore, cost-effective early diagnosis may be crucial in slowing disease progression and reducing the burden of care [7-9]. Research is currently being conducted to evaluate the use of bio-

markers from blood and cerebrospinal fluid (CSF) for the diagnosis of presymptomatic AD [10]. Knowledge of amyloid markers and their characteristics continue to evolve, including the understanding of levels of markers such as amyloid beta peptide (A β) in CSF [11]. The accumulation of A β is considered an indicator of disease progression in AD [12]. It was proposed that in the future, lumbar puncture may be employed for AD screening in a similar way to how colonoscopy screening is currently used for bowel cancer [13].

Having knowledge about AD is crucial in enabling early recognition, diagnosis and treatment of its symptoms [14]. Insufficient knowledge can affect individuals' attitude toward AD

[15]. Studies have shown that public awareness of AD is lagging, and there are many conflicting ideas about the diagnosis and treatment of the disease [14, 16, 17]. The general perception and attitudes toward “lumbar puncture testing for AD diagnosis” can impact the broad clinical availability of this diagnostic tool.

In this study, we conducted a questionnaire survey aimed to investigate public awareness and attitudes toward lumbar puncture in the diagnosis of AD, in the hope of providing evidence for proper management of AD.

Methods

Study design

The study was conducted from July 17, 2021 to July 31, 2021. The questionnaires were distributed at the First Affiliated Hospital of Xi'an Jiaotong University. Participants were divided into a non-medical group (n=403 participants) and medical group (n=647 participants). This study was reviewed and approved by the medical ethics committee of the First Affiliated Hospital of Xi'an Jiaotong University. Participants were required to meet the following criteria to be eligible for the survey: age: ≥ 18 years and native to Xi'an.

Survey and data collection

We conducted the survey through the “Sojourn” application on the WeChat platform. We designed a survey in WeChat. Anyone who was able to receive messages through the WeChat platform could participate in the survey. Participants were randomly selected by the Third company (Noel Biology Co., Ltd) and invited to participate this WeChat platform-based survey, with the aid of a marketing organization. Participants were required to access the “Sojump” interface through their cell phones and follow the instructions. The questions in the questionnaire included demographics (age, gender, marital status, education level, career, place of residence), knowledge of lumbar puncture, attitudes toward lumbar puncture for the diagnosis of AD, and reasons for having a negative attitude. Data from the questionnaire were then collected through the administration portal of the “Sojump” application.

Definition of variates

In this study, according to the occupation of the participants, we divided the participants

into a medical group and a non-medical group. Medical personnel were defined as working in a hospital. Education level was categorized as junior high school and below (less than 9 years of schooling), high school (9-12 years of schooling), and college and above (more than 12 years of schooling). Monthly income refers to the average monthly income of household members. Mental workers are those who mainly use the nervous system of the brain to accomplish their work, and physical workers are those who mainly use the motor system of the body or physical strength to accomplish their work.

Quality evaluation and implementation of the questionnaire

For questionnaire design, we reviewed literature, conducted a seminar for feasibility analysis, carried out theoretical analysis to develop a rigorous research plan, clarified the content of the study, and concretized each element of the study. To be specific, after reviewing the literature, a preliminary questionnaire was developed and improved through discussion with experts in the hospital. Then, the feasibility of the research questionnaire was also evaluated through discussion by experts in the hospital. We employed the Delphi method to determine the content validity of the questionnaire, thereby ensure the scientific validity.

During the survey, we strictly followed the inclusion and exclusion criteria to avoid selection bias. We tried to unify the standards, methods and survey techniques, so as to minimize the possible bias in the survey process. The same questionnaire and the same guidelines were used to conduct the survey, and the requirements were explained in detail to obtain participant cooperation.

Before data collection and entry, the questionnaire was verified to avoid missing items and omissions. Data entry was completed by double entry, and the questionnaire data were cleaned to ensure the completeness.

Statistical analysis

The data were imported into an Excel spreadsheet for analysis. Continuous variables meeting normal distribution were reported as mean \pm standard deviation, while categorical variables were presented as frequencies and percentages. Unpaired Student's t-tests were used for the processing continuous variables

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Table 1. Demographic characteristics of the participants

	Non-Medical personnel (n=403)	Medical personnel (n=647)	P
Gender			
Male (n, %)	144 (35.7)	128 (19.8)	< 0.001
Female (n, %)	259 (64.3)	519 (80.2)	
Age (years)	56.5 ± 13.5	37.6 ± 15.1	< 0.001
Residence			
Rural (n, %)	46 (11.4)	48 (7.4)	0.027
Urban (n, %)	357 (88.6)	599 (92.6)	
Education level			
Middle school or below (n, %)	49 (12.2)	0 (0.0)	< 0.001
High school (n, %)	79 (19.6)	10 (1.5)	
College or above (n, %)	275 (68.2)	637 (98.5)	
Marital status			
Single (n, %)	66 (16.4)	118 (18.2)	< 0.001
Married (n, %)	316 (78.4)	525 (81.1)	
Widowed (n, %)	21 (5.2)	4 (0.6)	
Occupation type			
Physical worker (n, %)	90 (22.3)	180 (27.8)	0.047
Mental worker (n, %)	313 (77.7)	467 (72.2)	
Working state			
Working (n, %)	275 (68.2)	628 (97.1)	< 0.001
Retired (n, %)	128 (31.8)	19 (2.9)	
Monthly income			
< ¥3000 (n, %)	68 (16.9)	42 (6.5)	< 0.001
¥3000-¥4999 (n, %)	129 (32.0)	177 (27.4)	
¥5000-¥9999 (n, %)	144 (35.7)	305 (47.1)	
≥ ¥10000 (n, %)	62 (15.4)	123 (19.0)	
Type of medical insurance			
Employee (n, %)	293 (72.7)	611 (94.4)	< 0.001
Others (n, %)	110 (27.3)	36 (5.6)	

and chi-square tests for categorical variables. Multivariate logistic regression analysis used to identify the factors influencing public attitudes. All statistical analyses were performed using SPSS Statistics version 24.0 (IBM, New York, NY, USA). A two-sided *p*-value < 0.05 was considered significant.

Results

Demographic characteristics of the participants

A total of 1065 participants took part in the survey, but 15 were excluded due to incomplete or inconsistent responses, thus 1050 (98.6%) responses were included in the analysis. As shown in **Table 1**, the participants were divided into two groups. A total of 403 (38.4%) were in

the non-medical group, of whom 111 (27.5%) were caregivers of AD patients, and 292 (72.5%) were from the general population. The medical group included 647 (61.6%) participants, of whom 492 (76.0%) worked in a tertiary hospital, 140 (21.6%) in a secondary hospital, and 15 (2.3%) in level I hospitals. There were statistically significant differences between non-medical and medical groups in terms of gender, age, place of residence, education, marital status, type of occupation, work status, monthly income, and type of health insurance.

Characteristics of participants with positive and negative attitudes to lumbar puncture

Among the participants, 862 (82.1%) had a positive attitude and 188 (17.9%) had a nega-

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Table 2. Factors influencing participants' attitude on lumbar puncture

	Positive attitude (n=862)	Negative attitude (n=188)	P
Gender			
Male (n, %)	209 (24.2)	63 (33.5)	0.009
Female (n, %)	653 (75.8)	125 (66.5)	
Age (years)	40.0 ± 15.6	47.5 ± 15.1	0.011
Residence			
Rural (n, %)	73 (8.5)	21 (11.2)	0.240
Urban (n, %)	789 (91.5)	167 (88.8)	
Education level			
Middle school or below (n, %)	26 (3.0)	23 (12.2)	< 0.001
High school (n, %)	50 (5.8)	39 (20.7)	
College or above (n, %)	786 (91.2)	126 (67.0)	
Marital status			
Single (n, %)	154 (17.9)	30 (16.0)	0.013
Married (n, %)	693 (80.4)	148 (78.7)	
Widowed (n, %)	15 (1.7)	10 (5.3)	
Occupation type			
Physical worker (n, %)	212 (24.6)	58 (30.9)	0.005
Mental worker (n, %)	650 (75.4)	130 (69.1)	
Working state			
Working (n, %)	768 (89.1)	135 (71.8)	< 0.001
Retired (n, %)	94 (10.9)	53 (28.2)	
Monthly income			
< ¥3000 (n, %)	73 (8.5)	37 (19.7)	< 0.001
¥3000-¥4999 (n, %)	248 (28.8)	58 (30.9)	
¥5000-¥9999 (n, %)	384 (44.5)	65 (34.6)	
≥ ¥10000 (n, %)	157 (18.2)	28 (14.9)	
Type of medical insurance			
Employee (n, %)	763 (88.5)	141 (75.0)	< 0.001
Others (n, %)	99 (11.5)	47 (25.0)	
Medical personnel or not			
No (n, %)	256 (29.7)	147 (78.2)	< 0.001
Yes (n, %)	606 (70.3)	41 (21.8)	

tive attitude on lumbar puncture in the diagnosis of AD. There were significant differences between these two cohorts in terms of gender, age, education, marital status, type of occupation, job status, monthly income, and type of health insurance. In addition, there was a significant difference between medical and non-medical groups (**Table 2**).

Factors influencing the attitude on lumbar puncture in the diagnosis of AD

Because of the differences in the demographic characteristics between medical and non-medical groups, these two groups were analyzed

separately in a multivariate logistic regression analysis, which was performed to investigate the factors associated with decision making. Attitude toward lumbar puncture in the diagnosis of AD was used as the dependent variable (negative attitude =0, positive attitude =1), and gender, age, place of residence, education, marital status, type of occupation, job status, monthly income, and type of health insurance were independent variables for non-medical personnel, and hospital level and department were additional independent variables for medical personnel. As shown in **Table 3**, factors influencing the attitude of the non-medical group included age (OR=0.963, P=0.003, 95%

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Table 3. Multivariate analysis of the factors influencing the attitude of the non-medical group

Variable	b	SE	Wald	P	OR	95% CI	
						Lower	Upper
Age	-0.038	0.013	8.910	0.003	0.963	0.939	0.987
Education level	0.729	0.350	4.343	0.037	2.073	1.044	4.114
Monthly income	0.293	0.135	4.679	0.031	1.340	1.028	1.748
Occupation type	0.450	0.217	4.318	0.038	1.569	1.026	2.400
Gender	1.327	0.498	8.875	0.055	0.029	1.025	4.895
Place of residence	2.575	1.233	9.987	0.087	0.036	0.783	1.376
Marital status	1.142	0.367	7.867	0.128	0.034	0.818	2.198
Job status	0.064	0.026	7.645	0.316	0.087	0.513	1.232
Type of health insurance	2.718	1.014	7.889	0.319	0.098	0.998	2.079

Table 4. Multivariate analysis of the factors influencing the attitude of the medical group

Variable	b	SE	Wald	P	OR	95% CI	
						Lower	Upper
Residence	2.217	1.059	4.380	0.036	9.182	1.151	73.238
Monthly income	1.388	0.441	9.913	0.002	4.008	1.689	9.511
Hospital Level	3.646	0.502	52.743	< 0.001	38.311	14.323	102.478
Age	1.048	0.675	4.770	0.019	0.076	1.032	3.298
Education level	2.037	0.909	5.024	0.055	0.628	1.222	45.528
Gender	-0.459	0.801	0.324	0.563	0.632	1.130	3.074
Marital status	0.891	0.484	0.149	0.903	2.499	0.471	4.647
Type of health insurance	1.305	0.597	4.770	0.119	3.386	1.143	4.448

CI: 0.939-0.987), education (OR=2.073, P=0.037, 95% CI: 1.044-4.114), monthly income (OR=1.340, P=0.031, 95% CI: 1.028-1.748), and type of occupation (OR=1.569, P=0.038, 95% CI: 1.026-2.400). As shown in **Table 4**, factors influencing the attitude of the medical group included place of residence (OR=9.182, P=0.036, 95% CI: 1.151-73.238), monthly income (OR=4.008, P=0.002, 95% CI: 1.689-9.511), and hospital level (OR=38.311, P < 0.001, 95% CI: 14.323-102.478).

Reasons for a positive attitude towards lumbar puncture in the diagnosis of AD

Of the 862 participants with a positive attitude, the majority (508, 58.9%) believed that lumbar puncture would help the diagnosis of AD, and 215 (24.9%) believed that the test would allow patients to receive earlier treatment. Details are shown in **Figure 1**.

Reasons for a negative attitude towards lumbar puncture in the diagnosis of AD

Of the 188 participants with a negative attitude, 80 (42.6%) believed that AD was currently

incurable and of little diagnostic significance, and 54 (28.7%) were concerned about harm from invasive procedures. Details are shown in **Figure 2**.

Discussion

The measurement of A β 1-42 and phosphorylated tau levels in CSF has been recommended by many guidelines and consensus [18, 19], but has not been widely used in clinical practice [20]. A considerable number of physicians believe that the reason for the limited use may be the invasive nature of lumbar puncture testing, which makes it less acceptable by the patients. However, the actual public attitude toward lumbar puncture for the diagnosis of AD is not clear.

In this study, we investigated the public awareness and attitudes toward lumbar puncture examination using a questionnaire survey. Surprisingly, the results showed that 82.1% of the participants had a positive attitude toward lumbar puncture examination in the diagnosis of AD, primarily because they believe the test helps in the diagnosis of AD and enables

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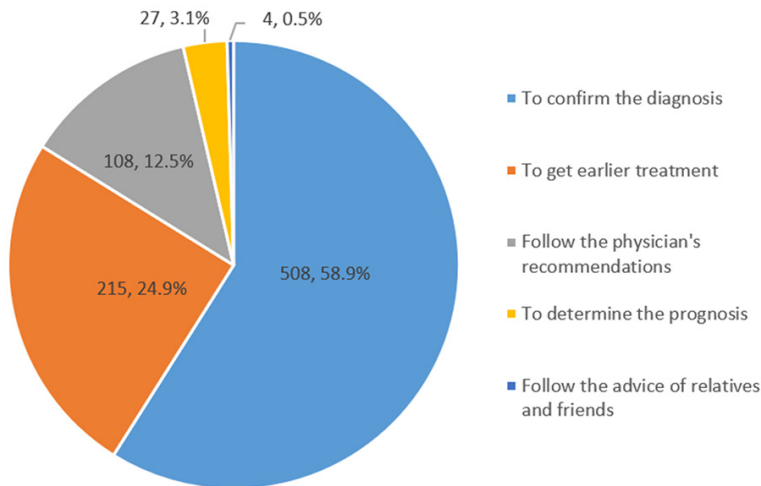


Figure 1. Reasons for a positive attitude.

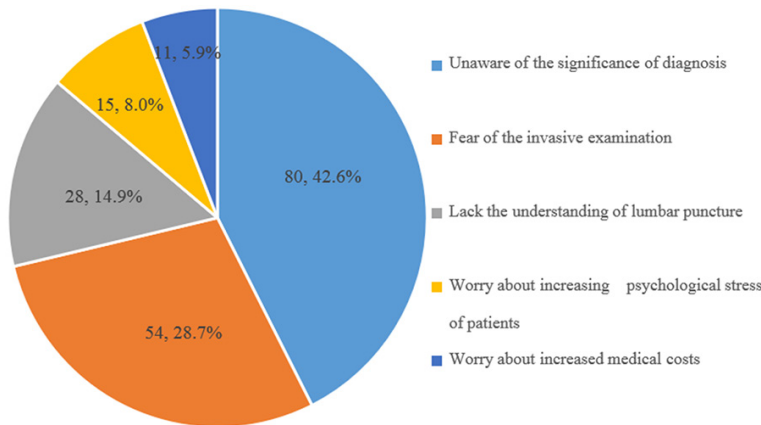


Figure 2. Reasons for a negative attitude.

patients to receive early treatment, especially among young, highly educated, better-off, brain-working non-medical personnel, and among better-off medical personnel living in urban areas and working in tertiary hospitals.

Lumbar puncture is generally perceived as invasive procedure, so most AD patients are reluctant to undergo it. However, in the present study, 82.1% of participants had a positive attitude toward lumbar puncture in the diagnosis of AD, indicating that the acceptance of lumbar puncture in the diagnosis of AD has been seriously underestimated in the past. We believe there are several explanations. First, detection of $A\beta_{1-42}$ and phosphorylated tau levels in CSF by lumbar puncture has been recommended by recent guidelines, and its important role in AD diagnosis has been widely known by the public.

Second, recent clinical studies have shown that early intervention can effectively delay the progression of AD [21], underscoring the importance of early diagnosis in patients. Third, public fear of lumbar puncture has been greatly reduced with improved health literacy. This is consistent with our findings that non-medical personnel who are young, highly educated, financially well-off or having more mental type of work are more willing to undergo lumbar puncture, as are well-off medical personnel who live in urban areas and working in tertiary hospitals. They may be more updated about new health concepts, more receptive to new knowledge and techniques, and have a greater awareness of disease prevention and treatment.

In this study, approximately 18% of the participants had a negative attitude. The main reason was that they believed that AD is currently incurable, so the diagnosis has little significance, indicating that some people have insufficient knowledge about AD. Although

AD is currently not completely curable, a large number of studies have shown that early diagnosis and reasonable treatment can effectively delay the progression of the disease and reduce the economic burden on families and society [21-24]. In 2019, the Chinese Food and Drug Administration approved sodium oligomers for the treatment of mild to moderate AD, which can effectively improve the cognitive function of AD patients and delay the progression of the disease [25-27]. In 2021, the US Food and Drug Administration approved Aducanumab for the early treatment of AD, which can reduce $A\beta$ deposition and tau phosphorylation, as well as delay disease progression [28]. These indicate that early diagnosis is important for AD patients. Therefore, we suggest that physicians should prioritize efforts in introducing the significance of early diagnosis

to facilitate patients' understanding of the importance of timely intervention.

Lumbar puncture is a common operation in clinical practice. It is relatively safe and does not cause significant harm to the patient [29-32]. However, people are concerned about the hazards associated with lumbar puncture, which was, in our results, the second reason why they were reluctant to undergo lumbar puncture. This suggests that some individuals may not fully comprehend the process and invasiveness of lumbar puncture. Physicians can potentially increase patient acceptance of lumbar puncture for AD diagnosis by taking the time to explain the procedure thoroughly and reassuring patients about its safety.

This study used the "Sojourn" application to collect the questionnaire, and participants voluntarily took part in the survey. Therefore, the results were influenced neither by sampling method nor the researcher. In addition, the "Sojump" application is a simple and feasible survey tool that is both cost-effective and efficient, making it readily accessible to the general public. However, this study also has some limitations. The subjects were native to Xi'an. Therefore, geographical bias exists in this study. In future studies, it would be beneficial to include participants from a wider range of geographic or national populations to ensure a more representative population distribution and accurate survey results.

Conclusion

More than 80% of the public has a positive attitude towards lumbar puncture in the diagnosis of AD, suggesting acceptability. However, the attitude toward lumbar puncture is depend on age, education level, economic status, and type of occupation.

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Subject participation was voluntary, and informed consent was obtained from all participants.

Disclosure of conflict of interest

None.

Abbreviations

AD, Alzheimer's disease; CSF, cerebrospinal fluid.

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