The prevalence of tinnitus in China: a systematic review of the literature

Author 1：Zhang Dawei MM

[1]Department of Otolaryngology Head and Neck Surgery, The Second Affiliated Hospital of Nanjing Medical University, China. [2]Hearing Sciences, Division of Clinical Neuroscience, School of Medicine, University of Nottingham, Nottingham, UK.

Author 2：Qin Xu PhD

[3]NHS Leicestershire Partnership Trust, Leicester, UK.

Author 3：Charlotte Caimino BSc

[2]Hearing Sciences, Division of Clinical Neuroscience, School of Medicine, University of Nottingham, Nottingham, UK. [4]NIHR Nottingham Biomedical Research Centre, University of Nottingham, Nottingham, UK.

Corresponding Author：David M Baguley PhD

[2]Hearing Sciences, Division of Clinical Neuroscience, School of Medicine, University of Nottingham, Nottingham, UK. [4]NIHR Nottingham Biomedical Research Centre, University of Nottingham, Nottingham, UK. [5]Nottingham Audiology Services, Nottingham University Hospitals NHS Trust, Nottingham, UK.

*Author to whom correspondence should be addressed; David Baguley: david.baguley@nottingham.ac.uk

Abstract

Purpose

The aim of the present study was to identify reports of the prevalence of tinnitus in China and to present these findings in a review format.

Method

We assessed and collated published prevalence estimates of tinnitus and tinnitus severity, creating a narrative synthesis of the data from publications identified from a combination of Chinese and English language databases.

Results

A total of 23 studies were included. Tinnitus prevalence ranged from 4.3% - 51.33% but varied with age and gender. The highest increase in prevalence from previous decade in age occurs during the fifth and sixth decades, and the highest prevalence was in the seventh decade at 32.47%. There is also evidence that tinnitus prevalence is related to certain risk factors including comorbid disorders.

Conclusions

The prevalence of tinnitus in mainland China in this study is consistent with global data. With increasing awareness of the prevalence of tinnitus in China, the development of epidemiological standards is a priority.

Keywords

Tinnitus, prevalence, China, epidemiology

Introduction

The nature of tinnitus is heterogeneous and is described as ringing, buzzing, clicking, hissing, roaring, humming, or pulsation[1]. The impact varies considerably in severity, ranging from mild to very bothersome [2,3]. Severe, persistent tinnitus commonly involves comorbidities such as sleep disturbance, anxiety or depression, which may substantially affect the patients' quality of life [4-7]. Curative treatment for tinnitus is not available at present [8] and current treatment approaches involve counselling and sound therapy [9]. Understanding the prevalence of a condition in a defined population is important for the improvement of health, and prevention of that condition [10]. Tinnitus is a frequent symptom in the developed world, though methodological issues mean that epidemiological studies report a wide range of prevalence in adults extending from 5.1% to 42.7% [11]. The reported prevalence of tinnitus is strongly influenced by the wording and context of the question asked[11], and populations outside USA and Europe are under-represented in the literature. A body of literature regarding the prevalence of tinnitus in China exists but is only available in Chinese and thus has hitherto been inaccessible to English speaking researchers. The present paper results from a collaboration between Chinese and English tinnitus researchers seeking to bridge that gap.

The aim of the present study was to identify reports of the prevalence of tinnitus in China, the majority in Chinese, and to present these findings in a review format. Given the variety of published estimates in China, we assessed and collated published prevalence estimates of tinnitus and tinnitus severity creating a narrative synthesis of the data. The variability between prevalence estimates was investigated in order to

determine any barriers to data synthesis and to identify reasons for heterogeneity.

Method

Eligibility criteria

We included studies reporting human participants in Mainland China. All studies were required to report the prevalence of tinnitus. Publications in the Chinese Simplified language were collected. Case-control studies, case reports, review papers and Chinese medicine treatment studies were excluded.

Search strategy

A total of 3 Chinese electronic databases (CNKI, VIP, WANFANG) [12] and 4 English electronic databases (PubMed, Medline, PsychINFO and Web of Science) were searched on 6 Dec 2019. A search strategy was carefully specified to capture all potentially eligible records relating to tinnitus prevalence. The Chinese literature was searched using the Chinese keywords which were translated into English "tinnitus AND (epidemiology OR epidemiology OR population OR incidence)". The English language electronic databases were searched using a strategy which consisted of a combination of MeSH terms and relevant text words including prevalence, tinnitus and China. A detailed search strategy is given in Supplementary Material 1.

Study selection and data extraction

Titles and abstracts of the search results were screened using an iterative approach by two native Chinese speaking researchers (ZD, QX) and non-relevant records were excluded. Any disagreements on texts for inclusion were reviewed by an independent researcher (DB) with a translated abstract. Full texts for those eligible for full text

screening were then retrieved and screened independently by two researchers (ZD, QX). An additional researcher was consulted to resolve any disagreements (DB). A data extraction form was created using Microsoft Excel and piloted using two records before finalizing for full data extraction. The final data items included for data extraction were: Author, year of study, publication categories, sample size, age, gender, recruitment/publication source, study design method, inclusion criteria and exclusion criteria, study period, location, question/definition of tinnitus or severity, and prevalence data, accompanying symptoms e.g. positive otological pathology or hearing loss.

Results

Search results

After the Chinese electronic research databases were searched, a total of 2,181 articles were detected in 3 databases. According to the topic, abstract, and full-text screening, 22 articles were selected for inclusion. A search of English language databases found a total of 1,184 articles in 4 databases. Following the topic, abstract, and full-text screening, one additional article was selected for inclusion. Therefore, a total of 23 studies were included in the review [13-35].

Study characteristics

The main purpose of the majority of the studies (18/23) was to assess the prevalence of tinnitus. The epidemiology of hearing loss, the association between tinnitus and noise, or obstructive sleep apnea hypopnea syndrome (OSAHS), or systemic diseases such as hypertension, and diabetes were investigated by 5 other studies. Most of the studies were from economically developed regions (Beijing, Jiangsu, Guangdong)[36] or populous provinces (Sichuan, Shaanxi, Henan, Liaoning), followed by Ningxia and Xinjiang which are located at the Western region of China. However, there is no data on the prevalence of tinnitus in other regions of China. Study characteristics of the included studies are detailed in Supplementary Material 2.

Prevalence

In order to comprehensively understand the current situation of tinnitus prevalence in Mainland China, as many studies as possible were collected on the prevalence of

tinnitus. In these surveys, the prevalence of total tinnitus ranged from 4.3% to 51.33%. The prevalence of tinnitus also ranged from 4.3% to 51.33% in 11 studies which used the definition “tinnitus lasted for more than five minutes”. The prevalence ranged from 7.8% to 34% after excluding 5 studies with ear or systemic diseases [17,21,32,33,35]. The prevalence of tinnitus ranged from 7.8% to 30.4% in 9 studies of the general population of all age groups [14,16,23-28,34].

Gender

After 2 studies [33,35] from hospital populations were excluded, 14 of the 23 publications reported prevalence of tinnitus in female and male populations in general separately [14-16,19-20,22-28,31,34] (Figure I).

(Insert Figure I here)

The prevalence of tinnitus for females ranged from 5.4% to 34.5%, and from 3.2% to 29.9% for males. Significant differences by gender in tinnitus prevalence were observed in 7 studies, such that 6 of these showed that the prevalence of females was higher than males and only 1 study reported the opposite result. While 3 of these only reported prevalence in percentages, 11 presented the number of tinnitus cases in the population studied [14-16,19,22-27,31]. By pooling these numbers together, the overall prevalence in each gender was calculated, being in females 15.25% and in males 13.66% (Table I). From these results an independent samples t-test revealed there was no significant effect of gender on tinnitus prevalence ($p = 0.58$).

(Insert Table I around here)

The reported prevalence of tinnitus is much lower in studies of teenagers (female 5.38-6.10%, male 3.23-3.50%)[19,20] and young adult populations (female 8.44%, male 8.18%)[31] than the other studies which involved adults or the population in general; the reported prevalence is also much higher in the study of elderly populations (female 29.06-29.92%, male 28.31-29.28%)[15,22].

Age

The prevalence of tinnitus in different age groups was presented in 15 studies [13-16,22-27,29,31,33-35] (Supplementary Material 3); 6 of these used the same or similar age ranges in their reports [13,16,22,25,26(transient tinnitus excluded),34]. The data from 5 studies [13,16,22,25,26] were pooled to evaluate the variation in different age groups (Table II).

(Insert Table II around here)

From the combined data, there is a trend of increase in tinnitus prevalence with age in China (Figure II); the highest increase in prevalence from previous decade in age occurs during the fifth and sixth decades. The prevalence seems to plateau at around 32%. In 1 of the included studies [34], the percentage of prevalence in different age groups is reported without the actual number of cases and the group sizes given, so their result is plotted separately. In this particular study, the trend of increasing prevalence with age is clear, but the prevalence recorded is much lower (Figure II).

(Insert Figure II here)

Definitions of tinnitus and tinnitus severity

Definitions of tinnitus

There was a wide variation in the definition of tinnitus used (detailed in Supplementary Material 4). Most studies used the definition or diagnosis that 'tinnitus or sound perceived in ear/skull non-pulsatile which is distinguishable from external sounds lasts for five minutes or more' (11/23); and 4 of the 12 studies had the same question in their questionnaire: "In the past 12 months or 1year, have you been bothered by ringing, roaring, or buzzing in your ears or head that lasts for five minutes or more? ". In 1 study [32] tinnitus was defined as 'lasting for more than 1 minute' and another[26] used the definition 'continuous tinnitus: lasts for 5 minutes or more, and transient tinnitus: lasts less 5 minutes'. There were no clear definitions of tinnitus, or references to definitions in the other 10 studies.

Severity of tinnitus

The severity of tinnitus was reported in 7 studies, 1 [22] merely reported 'intolerable tinnitus' at 11.30% (66 out of 584). There were 7 defined severity classifications being used across the other 6 publications[14,16,19,23,28,30]; 2 studies [14, 28] shared the same definition and 1 [28] applied an additional classification using a Visual Analogue Scale (VAS). In order to provide an overall evaluation of severity, the different classifications were converted into a unified broad classification that was reported by 2 of the studies [14, 28] (Table III). There were 6,580 tinnitus cases classified in 6 studies, 4,573 reported mild tinnitus (69.50%), 1,512 reported moderate tinnitus (22.98%) and 561 reported

severe tinnitus (7.52%).

(Insert Table III around here)

Lateralisation

There were 9 studies that looked at the lateralization of reported tinnitus [14-16,19,22-23,25,28,31]. All but 1 [14] showed a high prevalence of bilateral tinnitus (Figure III). The data from the 9 studies were pooled to evaluate lateralisation in the tinnitus population. Overall there were 7,632 reported tinnitus cases, of which 4,084 presented with bilateral tinnitus (53.51%), 1,744 presented with left ear tinnitus (22.85%) and 1,804 with right ear tinnitus (23.64%).

(Insert Figure III here)

Risk factors and Comorbidities

There were 18 studies which reported on the statistical analysis of the risk factors related to tinnitus [14-16,19,20,22-28,30-35] (detailed in Supplementary Material 5). Gender and age have been described above. It was reported in 5 of the 18 studies that hearing loss was related to tinnitus[16,30,33-35], 3 of the 18 studies were related to otological comorbidity[16,19,34], and 3 of the 18 studies reported that noise exposure was related to tinnitus[16,19,27]. The difference of urban or rural areas was related to tinnitus in 4 studies [15,16,24,34]; 2 of the 4 studies showed that the prevalence of tinnitus was higher in urban than in the rural areas [24,34], but the other 2 studies show higher prevalence in the rural than in the urban areas [15,16]. Three studies reported that hypertension and diabetes were

associated with tinnitus [25,32,34]. Two studies reported that heavy physical labour was associated with tinnitus [14,23], and 2 studies reported that poor sleep was associated with tinnitus [19,27]. There were also individual reports of operator (factory) work, education, being overweight, hyperlipidemia, and computer use time being related to tinnitus.

In comparison to the general population, the prevalence of tinnitus is significantly higher in those with systemic diseases [21,33,35] and otological comorbidity [17] (Table IV). A Mann-Whitney U test was conducted to compare the prevalence of tinnitus in the general population and those with a comorbidity. There was a significant effect of comorbid disorder on tinnitus prevalence (Mann-Whitney U ($n1 = 4$; $n2 = 19$) = 13.00, $z = -2.02$, $p = .043$), such that tinnitus prevalence was significantly higher in those with a comorbid systemic disease.

(Insert Table IV around here)

Hearing loss in tinnitus cases were reported in 5 studies; 3 of them were from general populations [13,14,23] and 2 were from hospital ENT, and chronic kidney disease (CKD) clinics[17,21]. When the general population studies were combined, it revealed that 42.20% (2825/6695) of tinnitus cases had a hearing loss; while the combined clinical studies showed that 61.33% (295/481) of ENT and CKD patients who had tinnitus also had a hearing loss.

Diagnoses of otological conditions accompanying tinnitus were reported in 2 large community studies which had a total of 38,120 participants when combined[14,23]. Altogether, there were 5,261 tinnitus cases identified and 50.66% (2665/5261) of these

had additional aetiology (Figure IV).

(Insert Figure IV here)

Discussion

This study outlined the sample collection, survey methods, definition, and data of tinnitus prevalence and severity in 23 Chinese studies and discussed how this literature reports the prevalence of tinnitus by age and gender.

The wide variability of methods, index questions, and sample characteristics in studies analyzed prevents the ability to combine data and perform meta-analysis. The following factors are of note:

Study populations from different age groups

In 9 studies of similar general populations from all ages the prevalence of tinnitus ranged from 7.8 to 30.4%, consistent with the variability of global prevalence of tinnitus reported by McCormack, et al (2016)[11] which estimates from 5.1% to 42.7%. When data was extracted from the 4 studies in which populations were elderly[13,15,22,30], it showed that the prevalence of tinnitus was 28.7% -51.3%, which was significantly higher than the prevalence in the general population. The prevalence of tinnitus from 3 studies of middle-school-students population [18-20] which ranged from 4.3% to 13.4%, was lower than the prevalence of the general population. There is a trend for prevalence of tinnitus to increase with age from the combined data and the highest increase in prevalence from previous decade in age occurs during the fifth and sixth decades.

Tinnitus prevalence and systemic diseases or otological comorbidity

In China the prevalence of tinnitus is substantially higher in those with systemic diseases [21, 33,35] than the general population. However, a recent study on the

epidemiology of tinnitus in the United Kingdom revealed cardiovascular comorbidities including hypertension were not associated with the risk of being diagnosed with tinnitus, and analysis of those diagnosed with diabetes mellitus revealed a decreased adjusted OR of 0.85 [39]. Another study from populations of Asian Americans show hypertension or diabetes mellitus were not associated with tinnitus prevalence [40]. The sample size in the 3 studies of patients with systemic diseases [21, 33,35] ranged from 115 to 255 and the prevalence ranged from 38.6% to 51.6%.

Otological comorbidity was associated with a higher risk of being diagnosed with tinnitus [39,41]. When the general population studies were combined, it revealed that 42.2% of tinnitus cases had a hearing loss, while the combined clinical studies showed that 61.3% of ENT and CKD patients who had tinnitus also had a hearing loss. Hearing assessments in 5 studies were made by Pure Tone Audiometry (PTA), tuning fork tests, or whispered words [13,14,17,21,23]. PTA was used to evaluate hearing loss in 2 studies [17,21]. Tuning fork tests or whispered words were used in 1 study [13] but HL criteria were unclear in these cases.

Definition of tinnitus and severity

Nearly half of the studies (11/23) used the definition “tinnitus lasts for five minutes or more”. This is consistent with the most common type of definition identified in global data by McCormack et al [11]. There are different definitions, no clear definitions of tinnitus, or no references in the other 12 studies. Although 7 studies reported the severity of tinnitus, the methods used to evaluate tinnitus severity in the research studies

reviewed vary widely. Therefore, it was not feasible to combine data and perform meta-analysis. The formulation of standard Chinese questions to define tinnitus and tinnitus severity would be beneficial for future epidemiological research.

The stated purpose of most studies was to explore the risk factors for tinnitus. In terms of gender, 6 studies showed that the prevalence in women was higher than men, and 1 study showed that prevalence in men was higher than women, unlike the report of McCormack et al [11] which reports a higher prevalence of tinnitus in males than in females [11]. In addition, other risk factors like hearing loss, otological disease, noise exposure, poor sleep, and general conditions are associated with tinnitus [41]. Four studies have reported the differences of tinnitus prevalence between urban and rural areas, and many influencing factors, such as education, economy, and medical conditions may affect the prevalence of tinnitus between urban and rural areas. The present data is equivocal regarding differences in prevalence between urban and rural populations.

Limitations

In terms of the publication dates of the identified studies, these were mainly concentrated in the 15 years between 2003 and 2018 and there are 10 studies in 2017-2018, accounting for nearly half of the published literature. This indicates that research interest in tinnitus has grown in recent years in China. However, the studies only investigated the tinnitus epidemiological situation in 9 regions, and the total sample size is n=72,361 which does not represent the national situation in China. If the regional scope and sample size were expanded in future surveys, the data would be more reliable

and other insights might be gleaned. Additionally, the prevalence of tinnitus in Hong Kong, Macau, and Taiwan was not within the scope of the present study because the medical system, lifestyle, and literature publication methods of these regions were considered to be substantially different to those in mainland China.

Conclusion

The prevalence of tinnitus in mainland China in this study is consistent with global data. This study reports that the prevalence of tinnitus increases with increasing age, but was not statistically different by gender. Otological comorbidity, hearing loss, noise exposure, and poor sleep are associated with the risk of developing tinnitus. With increasing awareness of the prevalence of tinnitus in China, the development of epidemiological standards is a priority, as are studies with larger numbers, and greater geographical reach.

Acknowledgements

David Baguley and Charlotte Caimino are supported by the UK National Institute for Health Research: their views are their own and do not reflect those of the National Institute for Health Research nor the UK Department of Health and Social Care.

Funding

This article presents independent research funded by the National Institute for Health Research (NIHR) Nottingham Biomedical Research Centre, International education training funding from School of International Education at Nanjing Medical University and Jiangsu Province Youth Medical Talents Plan Program (grant number QNRC2016679 to Zhang Dawei).

Conflicts of interest

None.

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Tables

Table I

Summary of total cases of tinnitus in female and male populations from 11 studies

	Combined cases of tinnitus	Combined sample size	Calculated Prevalence (%)
Female	4236	27778	15.25
Male	4130	30235	13.66
Total	8366	58013	14.42

Table II

Prevalence of Tinnitus Reported for Different Age Groups

Age Group (years)	Number of tinnitus cases	Total number of individuals	Prevalence (%)	Increase in prevalence from previous decade (%)
10-19	14	979	1.43	
20-29	61	1043	5.85	4.42
30-39	199	2107	9.44	3.59
40-49	248	1761	14.08	4.64
50-59	416	1801	23.10	9.02
60-69	915	3122	29.31	6.21
70-79	586	1805	32.47	3.16
80+	171	528	32.39	-0.08

Table III

Severity classification across different studies

Studies	**Severity classification used**	**Adapted classification in present study**	**Notes**

14	**Mild:** noticeable in quiet when paying attention **Moderate:** persistent, NOT affecting sleep and work **Severe:** intolerable, affecting work even disrupting sleep	No change	
16	Impact on 1) mood, 2) daily routine **No, Mild, Moderate, Severe** Meaningful tinnitus: scored moderate or severe on either mood or daily routine	Categories "**No"** and "**Mild"** combined as **Mild**	"mood" is used in the present analysis, as it has fewer in category "**No**"
19	Impact on 1) mood and study, 2) sleep **No, Mild, Moderate, Severe**	Categories "**No"** and "**Mild"** combined as **Mild**	"sleep" is used in the present analysis, as it has fewer in category "**No**"
23	**Mild:** Cured or used to it; **Moderate:** Persistent but not affecting mood; **Severe:** Serious negative impact on mood and quality of life	No change	
28	**Mild:** noticeable in quiet when paying attention; **Moderate:** persistent, NOT affecting sleep and work **Severe:** intolerable, affecting work even disrupting sleep; **Visual Alignment Scale:** 1-10	No change	Number of cases in **Mild, Moderate** and **Severe** was calculated from percentages given
30	**1:** occasional, non-bothersome **2:** persistent, more noticeable in quiet, non-bothersome **3:** persistent even in noisy environment, non-bothersome **4:** persistent and affecting concentration and sleep **5:** persistent severe impact on work **6:** severe, suicidal tendency	**Mild:** 1-2 **Moderate:** 3 **Severe:** 4-6	No cases reported for categories 5 and 6

Table IV

Reported tinnitus prevalence in different patient groups

	Sleep disorders (%)	Type II diabetes (%)	Kidney diseases (%)	Otological conditions (%)	Average across conditions
Female	44.12	47.50			45.81
Male	35.80	40.74			38.27
Total	39.96	44.12	51.60	51.33	**46.75**

Bullet Point Summary

- The aim of the present study was to identify reports of the prevalence of tinnitus in China and to present these findings in a review format
- The prevalence of tinnitus in mainland China in this study is consistent with global data
- The prevalence of tinnitus increases with age
- Otological comorbidity, hearing loss, and poor sleep among other conditions are associated with the risk of developing tinnitus
- With an increasing emphasis on the prevalence of tinnitus in China, the development of epidemiological standards is a priority

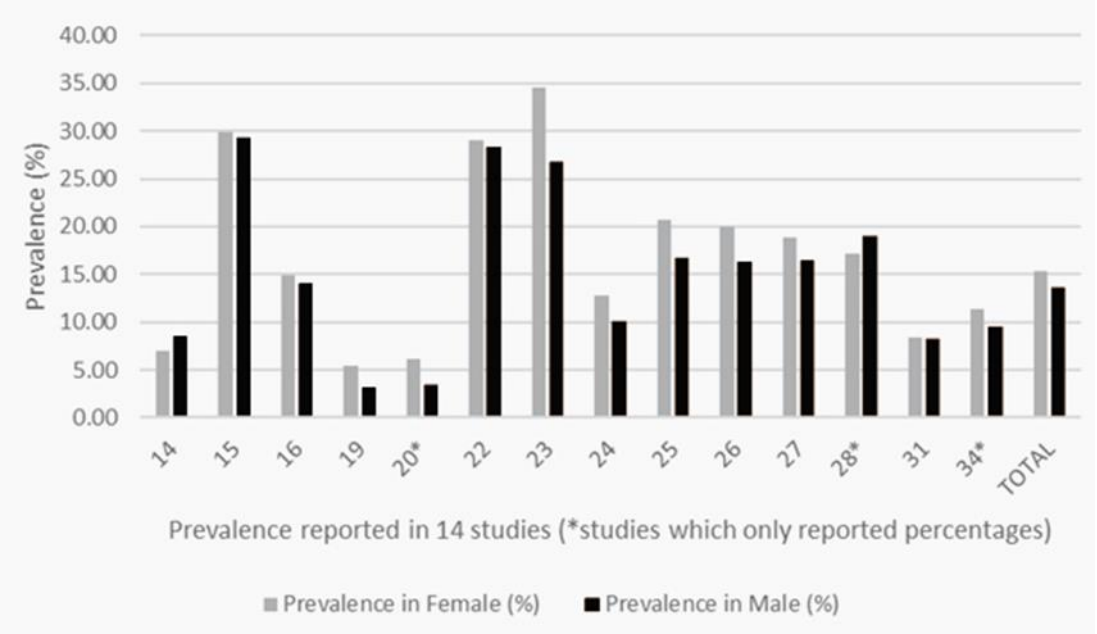

Figure I

Reported gender differences in the prevalence of tinnitus in China

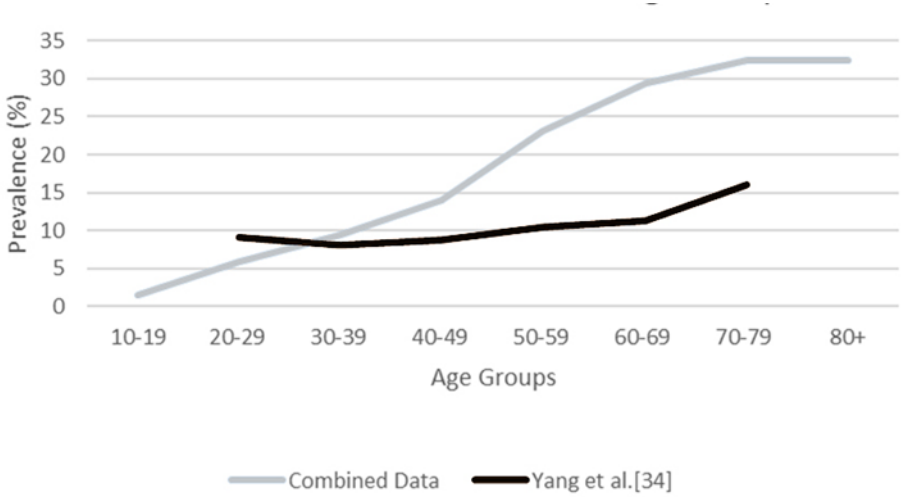

Figure II

Prevalence of tinnitus in China reported by age

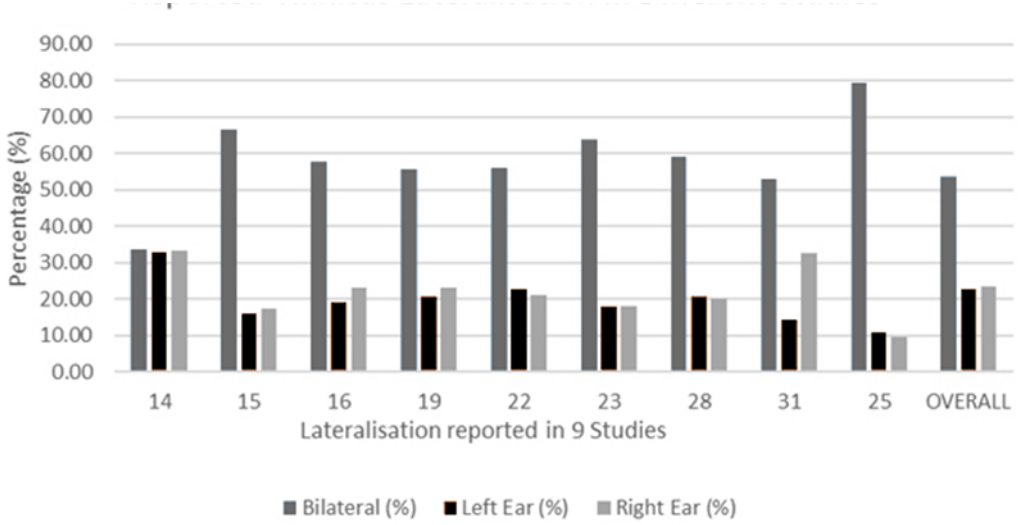

Figure III

Reported lateralisation of tinnitus

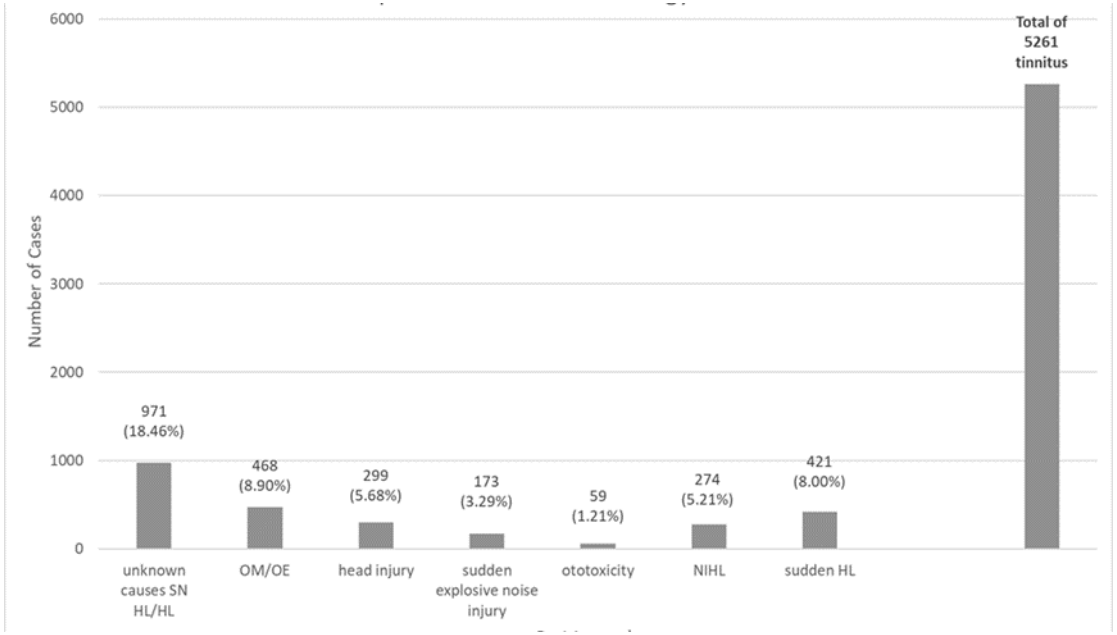

Figure IV

Reports of otological conditions in the Chinese population with tinnitus

Supplementary Material 1 Search strategy for English databases

	Search Terms
1	prevalence
2	tinnit*s OR tinnitus OR (ringing AND ear*) OR (buzzing AND ear*) OR (noise AND ear*)
3	(observational OR epidemiolog* OR epidemiology OR case control OR case control studies OR cohort stud* OR prospective studies OR cohort analy* OR cross section* OR cross sectional studies OR population)
4	China
5	1 AND 2 AND 3 AND 4

Supplementary Material 2 Study characteristics of the included studies.

STUDY REF	DATE (PUB. YEAR)	STUDY PURPOSE	AGE GROUP(M±SD)	STUDY LOCATION	POP NUMBER	GENDER (F:M)	POPULATION CATEGORIES	STUDY METHOD
HUANG W ET.AL.[13]	2003	hearing loss and tinnitus	60-98(69.6±7.2)	Beijing and adjacent rural areas	1434	873:561	General (elderly)	random cluster sampling
ZHU Y [14]	2005	tinnitus	9-80	Northern Shaangxi Region	28000	12635:15365	General	random cluster sampling
XU X ET.AL.[15]	2006	tinnitus	60-93(68.2±6.5)	Jiangsu	1149	601:548	General (elderly)	PPS
XU X ET.AL.[16]	2006	tinnitus and dizziness	10-93	Jiangsu	6333	3298:3035	General	PPS

LIU P ET.AL.[17]	2011	Tinnitus and Hearing Loss with different diseases	15-76(41.2±23.5)	Guangzhou,Guangdong	376	175:201	otological patients	convenient sampling
GAO L ET.AL.[18]	2011	noise-induced hearing impairment		Xingxiang, Henan	3826		University student	stratified random sampling
ZHANG S ET.AL.[19]	2012	tinnitus	(15.5±1.3)	Yinchuan Ningxia	2009	986:1023	middle school pupils	stratified random cluster sampling
LI Z ET.AL.[20]	2012	tinnitus	(15.7±1.4)	Xian, Shaangxi	1567	774:793	middle school pupils	stratified random cluster sampling
LIANG Y ET.AL.[21]	2012	tinnitus and hearing loss	15-64(AVG=44.8)	Beijing	223	124:99	Chronic kidney disease (CKD) patients	cross-sectional sampling
LI Y ET.AL.[22]	2013	tinnitus	⩾60	Foshan,Guangdong	2035	1046:989	General (elderly)	Home visit in 1 community district

HE Q ET.AL.[23]	2014	tinnitus	18-93	Kaifeng,Henan	10102	4828:5274	General	local population who attended health checks.
YIN Z ET.AL.[24]	2015	tinnitus	⩾20	Zhengzhou and adjacent rural counties	2526	1246:1280	General	stratified multistage cluster, PPS
HONG Z ET.AL.[25]	2016	tinnitus	14-88(48±16)	Dalian Liaoling	1596	848:748	General	convenient sampling(health check centre)
HONG Z ET.AL.[26]	2017	tinnitus	20-88(48.0±15.6)	Dalian, Liaoling	1748	942:806	General	convenient sampling(health check centre)
LU J ET.AL.[27]	2017	tinnitus	⩾9	Urumqi,Xinjiang	620	328:292	General	convenient sampling(health check centre)

LU J ET.AL.[28]	2017	tinnitus		Urumqi,Xinjiang	1574	866:708	General	9 community districts visited by resident/family inspector's door to door
LIU C ET.AL.[29]	2018	Auditory Characteristics	45-88(M=71)	Beijing	157	59:98	General (middle and elderly)	random sampling
HAN L ET.AL.[30]	2018	tinnitus and risk factors	60-93(71.4±8.26)	Beijing	150	84:66	General (elderly)	Recruited volunteers
DING Y ET.AL.[31]	2018	tinnitus and headphone	15-37(22.85±3.076)	Guangzhou, Guangdong	1909	1078:831	University student	convenient sampling
CHEN Y ET.AL.[32]	2018	hypertension, diabetes and tinnitus	19-80(60.4±4.8)	Zigong Sichuan	952	413:539	hospital in-patients	in-patients for HBP and diabetes

LIU B ET.AL.[33]	2018	diabetes and tinnitus		Beijing	255	120:135	diabetic patients	diabetic patients
YANG H ET.AL.[34]	2018	tinnitus and risk factors	⩾18	Guangdong	3705		General	4 stage PPS
LIU X ET.AL.[35]	2018	tinnitus and OSAHS	24-83(58.2±14.8)	Nagoya, Japan	115	34:81	OSAHS patients	OSAHS patients

Supplementary Material 3 Age groups of overall prevalence figures for 15 studies

Study ref	Age	Sample size	Current tinnitus Female (%)	Current tinnitus Male (%)	Current tinnitus Overall (%)	Bothersome tinnitus Overall (%)
Huang W et.al.[13]	60-69	259/765			33.8	
	70-79	176/503			34.9	
	80-89	53/166			31.9	
Zhu Y [14]	0-9	80/n			3.7	
	10-19	380			17.4	
	20-29	480			21.9	
	30-39	363			16.6	
	40-49	308			14.1	
	50-59	250			11.4	
	60-80	325			14.9	

Xu X et.al.[15]	60-69	197/703	28	2.4
	70-79	117/369	31.7	3
	80-93	26/77	33.8	1.3
Xu X et.al.[16]	10-19	13/958	1.4	0.1
(P <0 .05)	20-29	33/646	5.1	0.5
	30-39	123/1381	8.9	0.3
	40-49	164/1102	14.9	0.8
	50-59	245/1097	22.3	1.7
	60-69	197/703	28	2.4
	70-79	117/369	31.7	3
	80-93	26/77	33.8	1.3
LI Y et.al.[22]	60-69	332/1175	28.3	3.1
	70-79	190/655	29	3.7
	>80	62/205	30.2	2.4
He Q et.al.[23]	18-35	482/1576	30.6	
(P<0.05)	35-44	634/2404	26.4	

	45-59	1209/3495			34.6
	60-93	750/2627			28.6
Yin Z et.al.[24]	20-40	10/481			2.08
(P<0. 001)	41-59	35/354			9.89
	>59	243/1691			14.37
Hong Z et.al.[25]	14-19	1/21	14.3	0	4.8
(P<0.05)	20-29	13/184	9.8	4.3	7.1
	30-39	36/342	7.3	13	10.5
	40-49	40/308	12.7	13.2	13
	50-59	82/335	26.2	22.3	24.5
	60-69	62/229	27.3	26.6	27.1
	70-79	51/137	37.6	36.1	37.2
	80-89	15/40	33.3	46.2	37.5
Hong Z et.al.[26]	20-29	15/213	8.3	5.7	7
(P<0.001)	30-39	40/384	7.6	12.7	10.4
	40-49	44/351	12.7	12.4	12.5

	50-59	89/369	26.4	21	24.1
	60-69	65/250	26.4	25.3	26
	70-79	52/141	37.3	35.9	36.9
	80-89	15/40	33.3	46.2	37.5
Lu J et.al.[27]	9-18	1/3			33.3
	19-39	56/312			19.2
	40-60	50/286			17.5
	>60	3/19			15.7
Liu C et.al.[29]	45-59	9/86			10.5
	60-69	15/98			15.3
	70-79	8/88			9.1
	80-89	5/42			11.9
Ding Y et.al.[31]	15-20	28/423			6.6
	21-25	100/1154			8.7
	26-30	30/320			9.3
	31-35	1/11			9.0

	36-40	0/1			0.0	
Liu B et.al.[33]	<31	4/10			40	
(P=0.001)	31-40	3/12			25	
	41-50	13/48			27.1	
	51-60	36/83			43.3	
	>60	56/102			54.9	
Yang H et.al.[34]	18-30		11.3	6.6	9.1	
(P=0.001)	30-39		9.3	6.7	8.1	
	40-49		11.0	6.0	8.7	
	50-59		10.4	10.4	10.4	
	60-69		13.7	8.9	11.3	
	>69		12.6	19.2	16.0	
Liu X et.al.[35]	24-30	0/3				0
P<0.01	31-40	4/18				9.1
	41-50	3/16				6.8
	51-60	5/21				11.4

61-70	17/29	38.4
71-80	13/27	29.6
>80	0/5	0

Supplementary Material 4 Definitions of tinnitus prevalence and severity

Study ref	Date (Pub. Year)	Method	Question used about tinnitus	Diagnosis about tinnitus
Huang W et.al.[13]	2003	survey medical history		tinnitus lasts for 5 minutes or more[37]
Zhu Y [14]	2005	survey questionnaire[38], conducted by trained medical students.		tinnitus lasts for 5 minutes or more[37]
Xu X et.al.[15]	2006	questionnaire; ENT doctors trained to administer the same questionnaire: otological diseases; noise exposure; tinnitus.	In the past 12 months, have you been bothered by ringing, roaring, or buzzing in your ears or head that lasts for 5 minutes or more?	tinnitus lasts for 5 minutes or more in the past 12 months, excluding transient tinnitus after noise exposure
Xu X et.al.[16]	2006	questionnaire; ENT doctors trained to administer the same questionnaire:	In the past 12 months, have you been bothered by ringing, roaring, or buzzing in your ears or head that lasts for 5 minutes or more?	tinnitus lasts for 5 minutes or more

		otological diseases; noise exposure; tinnitus.		
Liu P et.al.[17]	2011	questionnaire	presence of tinnitus, exclusion of perception of ME fluid/cerumen movements/ external sounds	perceived in ear/skull non-pulsative sound which is distinguishable from external sounds, lasting longer than 5 mins.
Gao L et.al.[18]	2011	self-questionnaire and returning on site		Self-report, "chronic"
Zhang S et.al.[19]	2012	Chinese Middle School Pupils psychological health measurements, Athens Insomnia Scale (AIS) self-assessment		tinnitus lasts for 5 minutes or more[37]
Li Z et.al.[20]	2012			
Liang Y et.al.[21]	2012			
Li Y et.al.[22]	2013	questionnaire		Tinnitus classification Questionnaire[37]
He Q et.al.[23]	2014	questionnaire		tinnitus lasts for 5 minutes or more
Yin Z et.al.[24]	2015			

Hong Z et.al.[25]	2016			lasting ≥5mins.
Hong Z et.al.[26]	2017	self-questionnaire		>5 mins. Continuous tinnitus <5 mins. Transient tinnitus
Lu J et.al.[27]	2017	clinicians in health check center randomly distributed self-designed questionnaire, postal return.		tinnitus lasts for 5 minutes or more
Lu J et.al.[28]	2017	2000 questionnaire distributed and collected		tinnitus lasts for 5 minutes or more[37]
Liu C et.al.[29]	2018	Tinnitus classification questionnaire		Tinnitus classification Questionnaire
Han L et.al.[30]	2018	3 ENT doctors face to face interview using self-designed questionnaire		
Ding Y et.al.[31]	2018	self-designed questionnaire	In the past 12 months, have you been bothered by ringing, roaring, or buzzing in your ears or head that lasts for 5 minutes or more?	answer "yes" to tinnitus question and each time tinnitus occurs, it lasts >5 mins. Tinnitus > 6 month, chronic; tinnitus < 6 months, acute.

Chen Y et.al.[32]	2018	questionnaire	none	Inside ear or skull/head, there appears cicada sounds or chirping, humming and other different sounds, continuous or intermittent, lasting for more than 1 min. Defined so in ref. to "Applied ENT Head and Neck Surgery" and "Internal Medicine"
Liu B et.al.[33]	2018	survey questionnaire		
Yang H et.al.[34]	2018	structured questionnaire	In the past one year, have you been experienced any ringing, buzzing or other sounds in your ears?	intermittent and persistent tinnitus are included.
Liu X et.al.[35]	2018			

Supplementary Material 5 The risk factors related to tinnitus in 18 studies

Study reference	Age	Gender	Job	Otological and vestibular disorders	Hearing loss	Noise	Urban or rural	Systemic disease	Sleep	Education
Zhu Y [14]		male（P<0.05）	Manual workers（P<0.05）	P>0.05	P>0.05	P>0.05				
Xu X et.al.[15]	P>0.05	P>0.05					rural（P<0.05）			
Xu X et.al.[16]	elder(P<0.05）			OR:5.902	OR:6.718	OR:2.743	rural（P<0.05）			
Zhang S et.al.[19]	P>0.05	female（P<0.05）		P<0.05		time of headset(P<0.05)			insomnia(P<0.05)	
Li Z et.al.[20]		female（P<0.05）								
Li Y et.al.[22]	P>0.05	P>0.05			P>0.05					
He Q et.al.[23]	45-59(P<0.05）	female（P<0.05）	telephonist and manual workers	P>0.05	P>0.05	P>0.05				

			(P<0.05)						
Yin Z et.al.[24]	>60(P<0.05）	female（P<0.05）				urban(P<0.05)			
Hong Z et.al.[25]	>80(P<0.05）	female（P<0.05）					hypertension, diabetes, Hyperlipidemia, overweight (P<0.05)		
Hong Z et.al.[26]	P<0.05	female(P<0.05）							
Lu J et.al.[27]	P>0.05	P>0.05	P>0.05		time of headset(P<0.05)			P<0.05	
Lu J et.al.[28]		P>0.05							
Han L et.al.[30]	<70(P<0.05)			>60dB(P<0.05)					
Ding Y et.al.[31]	P>0.05								

Chen Y et.al.[32]						hypertension, diabetes(P<0.05)	
Liu B et.al.[33]	>60(P<0.05)	P>0.05		P<0.05			P>0.05
Yang H et.al.[34]	P<0.05	P>0.05	P<0.05	P<0.05	urban(P<0.05)	P<0.05	P<0.05
Liu X et.al.[35]	P<0.01	P>0.05		P=0.044			