

PREVALENCE OF HEARING LOSS IN ADOLESCENTS AND YOUNG ADULTS AS A RESULT OF SOCIAL NOISE EXPOSURE: META-ANALYSIS

Prevalência de perda auditiva em adolescentes e adultos jovens decorrentes de exposição a ruído social: meta-análise

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ABSTRACT

The exposure to noise in the teens and young adults leisure has drawn attention, given the impact of hearing loss in this population. This study had the purpose to estimate of the prevalence of hearing loss in this population resulting from exposure to social noise. Seventeen articles were identified for analysis that met the selection criteria on which it was observed information as design, age, location, evaluation mode, and the prevalence of hearing loss. The prevalence in the self-reported studies was less than 2% while those carrying audiometric ranged from 11.5 to 15.8%. It is concluded considerable heterogeneity between the prevalence of self-reported hearing loss and the measured by audiometric tests in the studied population.

KEYWORDS: Hearing Loss; Prevalence; Adolescent; Young Adult

■ INTRODUCTION

One of the biggest public health problems currently is the noise pollution and its effects on health, including hearing which, for this reason, has been broadly investigated^{1,2}. According to the World Health Organization (WHO), over 5% of the world population – 360 million people – have disabling hearing loss (328 million adults and 32 million children). And it is estimated that most of these people live in developing or underdeveloped³ countries. One of the most common causes of hearing loss are German measles infection during pregnancy, ear infections and prolonged exposure to loud noise that stands out as a leading cause of irreversible hearing loss^{4,5}.

There is an increase in hearing loss in children and adolescents related to recreational noise exposure¹. Many young people willingly expose themselves to high levels of noise intensity because of their habit of listening to music in bars, nightclubs, parties,

gyms and mainly using earphones of iPods, MP3, MP4, cell phones, among others, without worrying about the time and intensity of this exposure⁶⁻⁸. The WHO estimates that 1.1 billion young people, worldwide, may be at risk of hearing loss due to indiscriminate exposure to high intensity noise. In middle- and high-income countries, almost half of all adolescents and young adults (12-35 years old) are exposed to unsafe levels of sound because of the use of personal stereo devices. And 40% of them are exposed to potentially harmful sound.

In this context, evidence points that the extent and the degree of hearing damage continues to be directly related not only to the sound pressure level, frequency and duration, but also to individual⁷ susceptibility. The hearing loss will affect language and communication of these adolescents and young adults, harming their academic/cognitive, cultural, social and professional⁹⁻¹² development.

The aim of this paper is to describe the prevalence of hearing loss in adolescents and young adults (from 10 to 25 years old) due to social noise exposure, by reviewing some literature and listing the assessment procedures of the self-reported and measured studies.

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Conflict of interest: non-existent

■ METHODS

Search strategy and selection criteria

Literature systematic review, with the descriptors DeCS (Health Sciences Descriptors - BIREME) and MeSH (Medical Subject Headings, PubMed) was used without restriction: *prevalence(s) AND (hearing disorder(s) OR dysacusis OR hypoacusis OR hearing impairment OR bilateral deafness OR hearing loss, complete OR acquired deafness OR hearing loss, extreme) AND (adolescent(s) OR teen(s) OR teenager(s) OR teenager youth OR youths adolescence OR adult(s), young)*. Due to the differences of search mechanisms and uniterms recognized by each database, it was necessary to adjust the use of descriptors, for instance, including *prevalence* in the search on *Web of Science*. The search of articles was carried out in electronic databases - MEDLINE via PubMed, LILACS, WEB OF SCIENCE, SCOPUS and SCIELO.

The inclusion criteria regarded articles published between January 2000 and July 2013, with available abstract, with free or paid internet access. The search was conducted without any language restriction. Although later, only studies published in Portuguese, English and Spanish, which assessed the prevalence of hearing loss in adolescents and young adults, have been included in the phase of selection. The age classification followed the criteria of the World Health Organization which covers the period of adolescence in the age range of 10 to 19, while youth corresponds to the age group between 15 and 24 years old. The term “young adult” is also used referring to someone who is between 20 and 25 years old¹³.

Eligibility for studies

A screening of the localized studies was held, following the methodological steps proposed by the *Preferred Reporting Items for Systematic Reviews and Meta-Analyses - PRISMA*¹⁴, in order to select the texts that reported the prevalence of hearing loss due to noise exposure in adolescents and young adults. Two authors (A1 and A2) proceeded independently, and in a standardized manner, the selection of items identified in the databases, being eligible those which, by reading the title and / or abstract, contained data on the prevalence of hearing loss in the age group of interest (10 to 25). The divergences found were resolved by consensus, and the selection of articles to be read in full was established.

The exclusion criterion of the reading protocol selected articles, which had data of hearing loss associated with pre-existing conditions, genetic changes, cochlear implants, multiple disabilities,

syndromes, auditory neuropathy and / or middle ear pathologies.

Collected data

The reading of selected articles was carried out by two researchers using a checklist for studies assessment and a standard form which included the collection of the following information: authors, year of publication, country and population studied, design, sample size and description, participants' age range, hearing assessment mode, and prevalence of hearing loss in the age group of interest.

Study score analysis and assessment

The extracted data were compared by taking into consideration country of origin, type of study, sample size, participants' age group, type of auditory assessment and main observed results.

For the study scores assessment, the factors that could be potential sources of error were taken into consideration, such as sample size and method for hearing loss assessment (self-report or measured by instrument).

Studies received a score, considering the following criteria established by the authors: complete audiometric evaluation, incomplete (the ones that had only air conduction) or self-report; study population (population or specific group); age (age range or a specific age); protocol (WHO or others); and sample size (small, medium or large). From the score of each study, a score was established by quartiles, upper (above the third quartile), moderate (between the first and the third) and lower (below the first quartile).

Statistical analysis

A meta-analysis was carried out for those studies that showed the prevalence of hearing loss in certain age range. The heterogeneity of the studies was assessed by the inconsistency (I^2) which depicts the percentage variation attributed to them beyond chance. The following cut-off points were considered: 25% low; 50% moderate and 75% high heterogeneity, with p-value <0.05. Due to the high variability in the data, the random effect model was adopted. Initially, the prevalence was transformed into *logit* function to calculate its average. Then, they were weighed by the inverse of its variance. We used the *Forest* graphic for the presentation of the meta-analysis results and comparison of studies. Analyses were performed on the “meta” package from R software.

■ LITERATURE REVIEW

The electronic search in databases resulted in the identification of 438 articles. Twelve (12) studies were excluded due to duplicity, remaining 426 articles. Out of these, 354 were excluded because they did not have the criteria for inclusion after assessment of titles and abstracts. Among the 72 articles selected for full reading, 17 met inclusion criteria (Figure 1).

Table 1 depicts the 17 studies, organized according to the author, informing year of publication, country of origin, design, target population and sample size. Prevalence, age range of the study population and criterion to define hearing loss are presented in Table 2. In all, the studies were conducted with a population of 367,330 (three hundred sixty-seven thousand three hundred and thirty) adolescents and young adults, whereas

42,651 (forty-two thousand six hundred and fifty-one) have been reported with some level of hearing loss. Almost all the articles beheld men and women, except the ones about military service tracking which reported only results of young men. Three studies showed a higher prevalence of hearing loss in men.

Scores, conducted with established criteria, revealed three studies were considered high¹⁵⁻¹⁷, thirteen of them moderate^{10,18-29} and one study was low³⁰ (Table 1).

Concerning the design of the study, nine population surveys have been identified, a survey for scholars, another one for health service users. Five papers of tracking were selected, three on the assessment for military service, one on evaluation for job admission to enter an industrial workplace and the last one on university music students (Table 1).

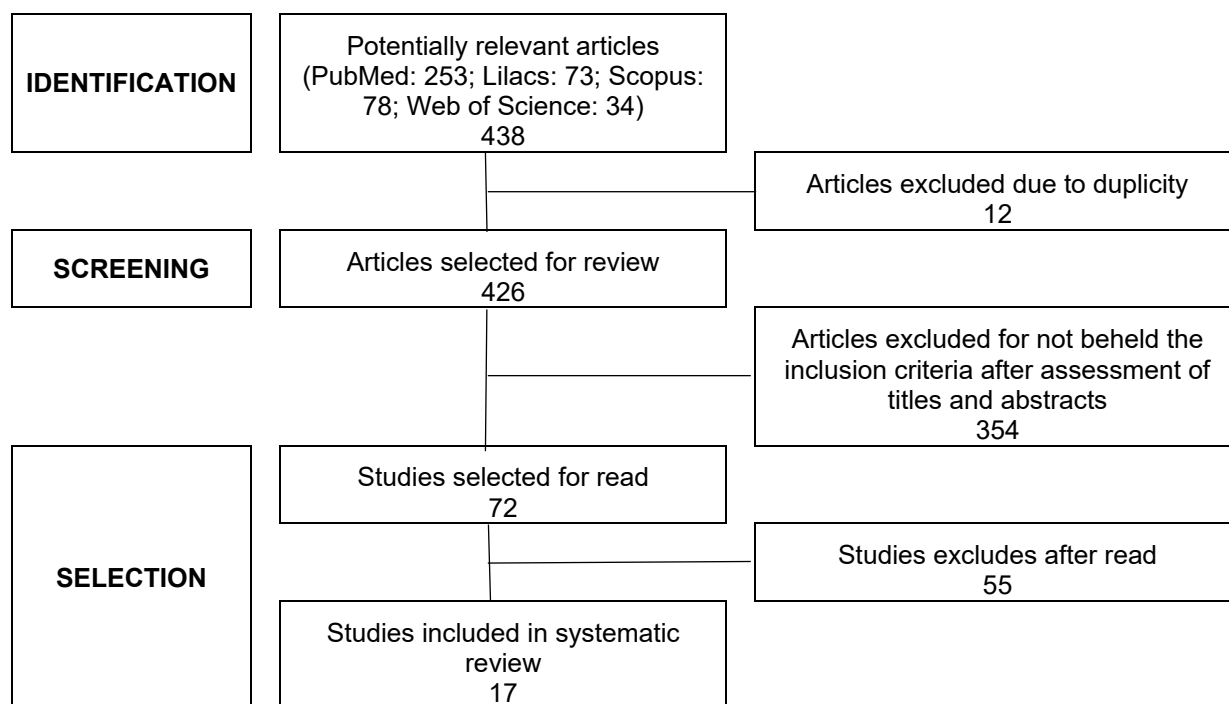


Figure 1 – Organogram – Schematic representation of the included articles selection process

Table 1 – Selected studies according to author, year of publication, country, type of study, target population and sample size

Author(s)	Year	Country	Type of study	Target Population	Quality of studies	Sample size
ABDEL-HAMID et al.	2007	Egypt	Household survey	Population Sampling	high	4000 (778 from 15 to 24 years old)
ABDEL-RAHMAN et al.	2007	Egypt	School survey	Secondary school students sampling	low	2589
KHABORI et al.	2007	Sultanate of Oman	Population survey	Population sampling	high	11402 (around 3400 from 10 to 19 years old)
DE ALMEIDA et al.	2009	Portugal	Household survey	Population sampling	moderate	9110 (1272 from 15 to 24 years old)
BÉRIA et al.	2007	Brazil	Household survey	Population sampling	moderate	2427 (493 from 10 to 19 years old)
CRUZ et al.	2009	Brazil	Household survey	Population sampling	moderate	5250 (s/d age range)
FLAMME et al.	2005	USA	Population survey	Rural Population (8 to 92 years old)	moderate	1972 (299 from 10 to 19 years old)
HENDERSON et al.	2011	USA	Population survey (NHANES 2005/6)	Population sampling (12 to 19 years old)	moderate	1791 (12 to 19 years old)
JOB et al.	2000	French	Tracking (military service, 1997)	Young men examined for military service sampling (28 to 24 years old)	moderate	1208 (18 to 24 years old)
MUHR et al., 2007	2007	Sweden	Tracking (military service - 1971 a 1995)	Young men examined for military service	moderate	301873
MUHR et al., 2010	2010	Sweden	Tracking (military service - 2002 a 2004)	Young man examined for military service sampling (median: 19 years old)	moderate	839
NISKAR et al.	2001	USA	Population survey (NHANES 1988/94)	Population sampling (6 to 19 years old)	moderate	5249 (6 to 19 years old)
PALMER et al.	2002	Great Britain	Health service user survey	Health service record sampling	moderate	12907 (s/d age range)
PHILLIPS et al.	2010	USA	Tracking (university student musicians)	university student musicians (18 to 25 years old)	moderate	329
RABINOWITZ et al.	2006	USA	Tracking (admission test for industry)	Just admitted at Alcoa, under 26 years old	moderate	2526
RENICK et al.	2009	USA	Population survey	Farmers population sampling	moderate	212 (204 from 12 to 19 years old)
SCHMITZ et al.	2010	Nepal	Population survey	Rural youth population sampling	high	3646

Lack of uniformity was observed in the age groups reported in the articles. Although all studies included young people, there was great variety among them: the minimum age ranged from 10 to 19 years old and the maximum from 15 to 24 years old (Table 1). It is not easy to estimate the contribution of this variability, since there is not a clear relation, in the selected studies, between age groups and the prevalence of hearing loss.

When people from several age ranges are compared, adolescents must be considered an age group who is susceptible to non-occupational noise-induced hearing loss and to the extra-auditory

effects of noise, due to their leisure activities using technologies almost always under continuous and severe noise exposure. Currently, it is common for young people to use earphones of modern electronics, without regard to the duration and level of exposure. It is known that its intensive use can affect hearing and, consequently, language and communication, leading to impairment of cognitive, cultural, social and professional development. In this context, it is important to conduct studies to identify the temporary hearing threshold shifts, in order to prevent permanent damage.

Regarding the countries of origin for the research, six (35.3%) were in the USA, five (29.4%) in European countries, two (11.8%) in Brazil and four (23.6%) in other parts of the world (Table 1). Studies conducted in the United States of America had a mean prevalence of 14.7% (95% CI 13.5 to 16.0; I^2 : 66.7%; $p = 0.01$). The mean prevalence of those conducted in Europe was 5% (95% CI 1.6 to 13.5) and the ones developed in other countries was 10.2% (95% CI 5.0 to 17.0), and high heterogeneity was observed in these last two study groups, with I^2 : 99% and p value <0.001 .

It should be noted that the two studies conducted in Brazil were quite distinctive household surveys. Béria and collaborators¹⁸ carried out an audiological evaluation in children who were over four years old in a sample of the population from Canoas, RS, in 2003. They studied frequencies of 0.5 to 8 kHz and classified as mild hearing loss from 26 dB, detecting a prevalence of 7.1% in the age range from 10 to 19 years old. Cruz and collaborators¹⁰ estimated hearing loss through interviews in which the

participant responded whether they had a closed set of disabilities, including deafness. The study was conducted in six urban areas of São Paulo state, from 2001 to 2002. In the age group of 12 to 19 years old, the prevalence of self-reported hearing loss was 2.0% (95% CI: 1.3 to 3.1)

The procedures for hearing loss assessment in the studies of this review can be classified into three groups. In the first, there are four studies (23.5%) that used the WHO *Ear and Hearing Disorders Survey Protocol for the Population-Based Survey of Prevalence and Causes of Deafness and Hearing Impairment and Other Ear Diseases*, which proposes two stages of assessment, covering environmental noise measurement, application of questionnaire, otoscopy, pure-tone audiometry (over 4 years old) and impedanciometry. In the second group, there are nine surveys (52.9%) which use their own protocol for hearing loss assessment. Finally, the third group (23.6%), three studies were self-reported and evaluated with a tuning fork (Table 2).

Table 2 – Selected studies according to author, year of publication, age range, prevalence and criterion for hearing loss definition

Author(s)	Year	Age range (years old)	Prevalence (%)	Definition criterion		
				Assessment	Hearing loss	Used protocol
ABDEL-HAMID et al.	2007	15 to 24	10,3	Test	26 dB	WHO
ABDEL-RAHMAN et al.	2007	13 to 21	22,2	Tuning fork test	-	-
KHABORI et al.	2007	10 to 19	23,8 *	Test	26 dB	WHO
DE ALMEIDA et al.	2009	15 to 24	0,9	Self-reported	-	-
BÉRIA et al.	2007	10 to 19	7,1	Test	26 dB	WHO
CRUZ et al.	2009	12 to 19	2,0	Self-reported	-	-
FLAMME et al.	2005	10 to 19	14,4	Test	26 dB	Family Health and Hazard Survey
HENDERSON et al.	2011	12 to 19	12,9	Test	26 dB	Own protocol
JOB et al.	2000	18 to 24	15,0	Test	16 dB	Own protocol
MUHR et al., 2007	2007	18	11,9	Test	26 dB	Own protocol
MUHR et al., 2010	2010	19 to 22	14,5	Test	26 dB	Own protocol
NISKAR et al.	2001	12 to 19	15,5	Test	16 dB	Own protocol
PALMER et al.	2002	16 to 24	around 1,0	Self-reported	-	-
PHILLIPS et al. (HW met)	2010	18 to 25	11,5 **	Test	16 dB	Own protocol
RABINOWITZ et al.	2006	17 to 25	15,8	Test	16 dB	Own protocol
RENICK et al (prot pp).	2009	12 to 19	19,3	Test	16 dB	Own protocol
SCHMITZ et al. (WHO)	2010	15 to 23	11,8	Test	26 dB	WHO

* unilateral hearing impairment; ** bilateral hearing impairment.

The four studies which evaluated hearing loss by the World Health Organization protocol presented a mean prevalence of 12.2% (95% CI 6.0 to 20.0) and considerable heterogeneity I^2 : 99.1%, p -value <0.001 . Value similar to that observed in those eight ones which used their own protocols: 11.6% (95% CI 9.0 to 14.1; I^2 : 97.6% and p -value <0.001).

Five papers considered high frequency tonal threshold, classifying mild hearing loss from 16dB and observed prevalence near 15%²⁴⁻²⁹. Four studies considered the mean of three frequencies (i.e. 500Hz, 1Khz and 2Khz) and established the mild hearing loss from 26dB^{15,16,18,24}. The studies using the cutoff point for mild hearing loss from 26dB showed greater variability in the prevalence of hearing loss: 7.1 to 23.8%

Studies with self-reported assessment of hearing loss showed lower prevalence than the ones that applied some type of measurement. This lower prevalence can be explained by the fact that high frequency hearing loss is barely perceptible, since it does not bring impact or obvious signs which impair daily activities³¹. This procedure underestimates hearing loss and can be a source of bias in interpreting results.

Differences found in the results may be explained, at least partially, by methodological aspects, especially those related to the definition criteria for hearing loss. The study of Abdel-Hamid and collaborators¹⁵ used tuning fork test as a clinical procedure to diagnose hearing loss, while others used pure-tone audiometry, which is a test usually indicated for the determination of hearing thresholds (Table 2). Another potential source of variability in the prevalence of hearing loss is the subjectivity of pure-tone audiometry, which may underestimate or overestimate the true prevalence, giving the possibility of false positives³².

The conduction of otoscopy procedure as a careful inspection of the external auditory canal and tympanic membrane viewing is essential to control possible biases in audiometric results. Although it has no diagnostic aim, the test may provide information indicating infeasibility to conduct a pure-tone audiometry. Thus, absence of otoscopic data may suggest inaccuracy in the audiometric results due to the possible presence of foreign bodies and cerumen that would prevent a correct detection of pure-tone thresholds^{33,34}. The papers that chose to conduct otoscopy, together with pure-tone audiometry and tympanometric results certainly bring a set of clinical information that can provide accurate data of

hearing thresholds. Complementary observations of the inspection procedure, added to those disclosed by the tests, will surely reveal the audiological condition more accurately^{34,35}.

Shortage of papers in the established age group (15 to 24 years old) was a limitation of this study. Nevertheless, it was possible to identify studies which, even covering wide age ranges, showed prevalence by age strata. Another matter which is worthy to note is the variability in the prevalence of hearing loss in adolescents and young adults. It can be attributed, among other aspects, to different hearing loss identification models used in the studies, as well as the criteria for loss of degree classification, and also the diversity of the age group included in them.

In summary, in this meta-analysis, it was possible to observe a mean prevalence (meta-prevalence) of 12.0%, (95% CI 0.8 to 15) (Figure 2). It is worth noting the strong influence of both self-reported studies whose prevalence were 0.9% and 2.0%, while in the studies that measured hearing there was a variation from 7.1% to 23.8%.

■ CONCLUSION

Reading the papers, it was possible to identify a significant heterogeneity between the prevalence of self-reported hearing loss and the one measured by objective criteria. While in self-evaluation less than 2.0% of young people mentioned they had any deficit, studies conducting audiometry showed higher prevalence between 11.5 and 15.8%.

Currently, the use of earphones without any worry about duration or level of exposure is common. It is important to conduct studies to identify the temporary changes in the hearing threshold, in order to prevent permanent damage.

The necessity for research focusing on the population of adolescents and young adults is noteworthy, since they represent a part of the population who is susceptible to irreversible hearing loss due to high levels of indiscriminate non-occupational noise exposure intensity.

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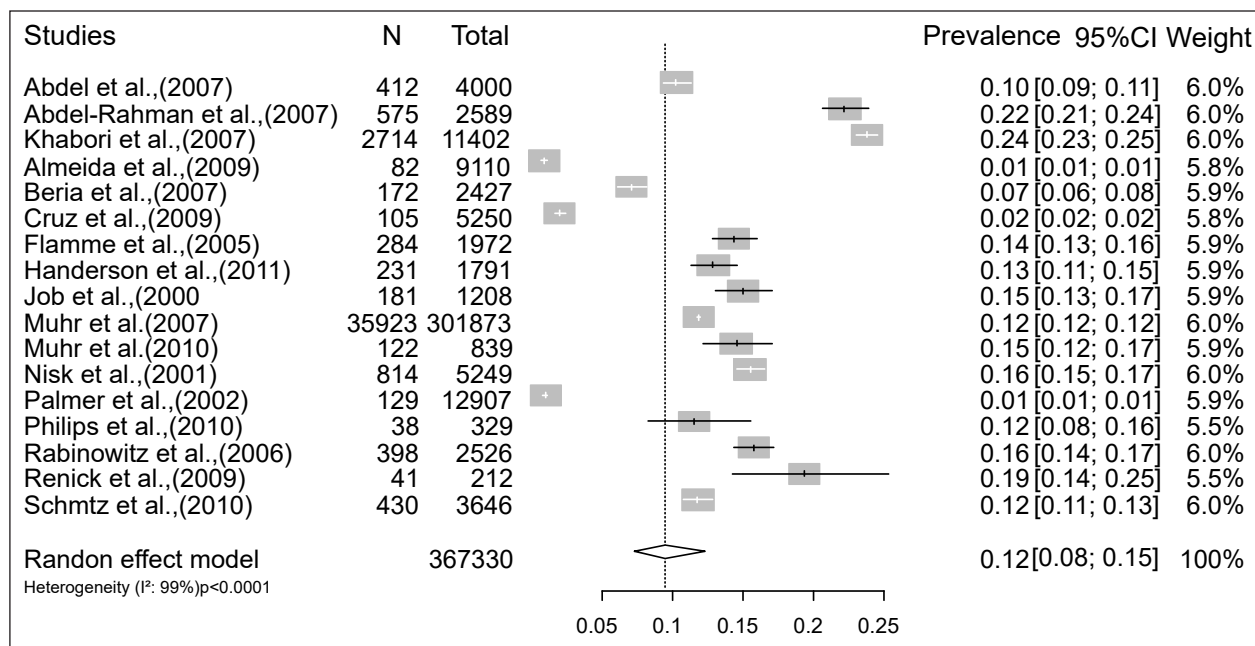


Figure 2 – Prevalence of hearing loss in adolescents and young adults

RESUMO

A exposição a ruídos no lazer de adolescentes e jovens adultos tem chamado atenção, dada a repercussão da perda auditiva nessa população. Esse estudo propôs estimar a prevalência de perda auditiva dessa população decorrentes de exposição a ruídos sociais. Foram identificados 17 artigos para análise que atenderam aos critérios de seleção, sobre os quais se observaram informações de: delineamento, faixa etária, localização, modo de avaliação e a prevalência de perda auditiva. Nos estudos autorreferidos, a prevalência foi inferior a 2%, enquanto aqueles que realizam audiometria foi de 11,5 e de 15,8%. Concluiu-se uma heterogeneidade entre a prevalência de perda auditiva autorreferida e a mensurada por exames audiométricos na população pesquisada.

DESCRITORES: Perda Auditiva; Prevalência; Adolescente; Adulto Jovem

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