Meta-Analysis of the Disease Spectrum of Hospitalized Crew-Members

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Research

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Abstract

Background: The disease spectrum of hospitalized crew-members could give good service to the support of health management. However, the disease spectrum of Chinese crew-members is still obscure.

Methods: Four different database were searched with keywords. Papers were included and excluded using given rules. Data such as publishing year, investigation period, subject resources, total number of subjects, name of diagnosis, proportion of diseases were extracted for investigation. Then the investigation year(before 2010 or after 2011) was applied for sub-analysis in further research.

Results: 24 results of disease spectrum of crew-members from numbers of hospitals were meta-analyzed. The first common disease was cervical and lumbar spine disorder which occupied 10% of diseases for hospitalization. And the other diseases followed it were hyperlipidemia(8%), cervical spine disease(7%), neurasthenia(6%), hypertension(6%), gastritis and duodenitis(6%), headache(6%), vegetative nerve functional disturbance(6%), upper respiratory infection(6%), fatty liver(5%), gastric and duodenal ulcers(4%), arrhythmia(4%), ground syncope(3%), urinary calculus(3%) and poor acceleration tolerance(2%), respectively. The spectrum of diseases was sub-analyzed by investigation year for further exploration. The proportion of cervical and lumbar spine disorder increased dramatically in the group of after 2011.

Conclusion: Our work gave evidenced-based support for disease spectrum of crew-members, pointed research directions for treatment and prevention of crew-members' common diseases, supported health strategy constitution of crew-members and guided well allocation of medical resources.

Background

Crew-members are groups of people working in the sky. They work in specially tough environment, frequently exposed to low pressure^[1], chemicals^[2], acceleration^[3] and so on. This makes crew-members at great risk for diseases. In one word, crew-members are taking high risks at work.

Getting hold by diseases and being detained in hospital would stop them from working in the air. Once there is a problem with the health of crew-members, the aeronautical training and duty will be seriously interrupted^[4]. Therefore, the support for health management of crew-members is profoundly crucial.

The disease spectrum of hospitalized crew-members could support well to health management of crew-members^[5]. The disease spectrum is the summarized results of common diseases of crew-members. It could recognize the frequently happened diseases that stop them from normal work and training. It gives a brief descriptions of diseases causing crew-members' hospitalization^[6]. It could also be sub-analyzed with different factors, such as time, age for further investigation^[6]. It also draw attention for aviation doctor and scholars on typical diseases, especially those at the top of the spectrum. In this way, the specialists could focus on the reason of variation of disease spectrum, also could come up with effective

strategy of treatment and prevention. Therefore, the disease spectrum of crew-members could achieve better health services for crew-members.

However, the disease spectrum of Chinese crew-members is still obscure. Zhang et al concluded that cervical/lumbar spinal disease and hypertension are top 2 categories for hospitalized crew-members, up to 9.30% and 7.97% respectively^[7]. But Yang et al, through collection of diseases causing hospitalization of pilots, realized the top two ranking diseases are cervical/lumbar spinal disease and hyperlipidemia, up to 8.03% and 7.05% respectively. And the percentage accounted for hypertension in their disease spectrum only take 1.86%^[6]. These results lacking consensus in proportion of diseases of hospitalized crew-members.

The reason for getting hard to draw consensus of disease spectrum may as follows. First, the overall number of crew-members is small, let alone the small numbers of crew-members enrolled in the investigation of disease spectrum. Second, the reports of disease spectrum comes from one hospital. This lacks integrated analysis with numbers of centers which might be another reason for differences of spectrum.

Therefore, our paper collected the published articles from multi-center that related to Chinese crew-members spectrum, extracted and synthesized the data from these articles which involved huge number of subjects, in order to give a robust evidence of the spectrum of Chinese inpatient crew-members. We came a conclusion for disease spectrum of Chinese crew-members. The frequently happened diseases were presenting in our disease spectrum of Chinese crew-members. We further sub-analyzed the spectrum of diseases by investigation year for advanced exploration. Our work gave evidenced-based support for disease spectrum of Chinese crew-members, pointed research directions for treatment and prevention of crew-members' common diseases, supported health management of Chinese crew-members and guided well for allocation of medical resources.

Methods

Data sources and search strategy

Two investigators(Zhouheng Ye and Tianyi Zhang) conducted systematic literature review using dataset. The database included China national knowledge infrastructure (CNKI)(Published from 1990 to 2020), Wangfang Data(Published from 1990 to 2020), VIP Database for Chinese Technical Periodicals (VIP) (Published from 1990 to 2020)and PubMed(Published from 1990 to 2020). Papers related with description of disease spectrum of Chinese crew-members were searched. While the search formula is varied according to different database, the search keywords is same in each database, named as “aircrew ” and “inpatient or hospitalization” and “disease spectrum”. The Chinese version of search keywords was used in Chinese Database. The same paper was merged after reading essential information, such as title, author and publication year, of each paper. Then the full copy of the filtered paper was downloaded for further review.

Inclusion And Exclusion Criteria

The inclusion and exclusion criteria are as follows. Inclusion criteria: ☐Subjects are crew-members from mainland of China; ☐The research style is cross-sectional study;☐ The subjects' hospitalization is caused by diseases;☐ The diagnosis of disease is clear, specified as organ + disease; ☐ Data resources is well-defined. Also clear are the spectrum period, total number of subjects and percentage for typical disease. ☐The diseases with over 6 reports of proportion were qualified for inclusion. Exclusion criteria: ☐ The paper is reported by sanatorium and lack specific diseases;☐ Diagnosis is defined in the way of systematic diagnosis, such as digestive disease or in the way of department + disease, such as orthopedic disease, endocrinology disease and so on; ☐ The total number of subjects is missing or the proportion of disease is missing; ☐ Research focus only on specialized fields and results of disease spectrum showed only on specialized fields. Study selection and application of inclusion criteria were carried out independently by the two investigators who conducted the literature search(Zhouheng Ye and Tianyi Zhang).

Data Extraction

Data extraction was independently performed by two investigators(Zhouheng Ye and Tianyi Zhang). The following information was extracted from each eligible study: author, year, study period, subject resources, total number of subjects, name of diagnosis, proportion of diseases.

Search results and study characteristics

The complete selection process is as follows(Fig. 1). 206 records were retrieved by our search strategy. We excluded 165 articles after reading the titles and abstracts, and retained 41 articles for further evaluation by reading the full articles. Finally, we selected 24 full-text articles about hospitalization disease spectrum of Chinese crew-members. The sample sizes reached up to 26983 within the analysis.

Sub-analysis

We divided included papers by investigation year. The sub-analysis of investigation year applied to 14 kinds diseases out of all common diseases. The proportion of disease in sub-group was meta-analyzed using same way above.

Statistical analysis

We calculated the proportion of disease spectrum of hospitalized crew-members based on the proportion and 95% confidence intervals published in each study. Meta-analyses were conducted in R version 4.0.3, using the MetaProp command in the “meta” package^[8]. Pooled proportions were estimated using random effects models. Heterogeneity between studies was evaluated using the I² statistic (p-values for

heterogeneity). All statistical tests were 2-sided, and a P-value < 0.05 was considered to be statistically significant.

Results

Table 1 showed general characteristics of the 24 studies included in the analysis. The year of publication ranged from 1996 to 2019. The investigation duration was from 1958 to 2018. There are total 26983 subjects involved in meta-analysis. Fifteen kinds of diseases were involved in the investigation. Cervical and lumbar spine disorder included 23 research papers for investigation which was the most within all diseases. Neurasthenia included the least for investigation, only 6 papers.

Table 2 showed the proportion of diseases that is commonly happened in the hospitalized population of Chinese crew-members using meta-analysis. The first disease was cervical and lumbar spine disorder which occupied 10% of disease for hospitalization. And the other disease followed it was hyperlipidemia(8%), cervical spine disease(7%), neurasthenia(6%), hypertension(6%), gastritis and duodenitis(6%), headache(6%), vegetative nerve functional disturbance(6%), upper respiratory infection(6%), fatty liver(5%), gastric and duodenal ulcers(4%), arrhythmia(4%), ground syncope(3%), urinary calculus(3%) and poor acceleration tolerance(2%) respectively. The cervical and lumbar spine disorder was the leading disease with pooled proportion of 10%, 95%CI 8–13%. There were 2026 subjects out of 23 research records involved in the investigation. The p value of heterogeneity was < 0.05 while the p value of egger's test was over 0.05. Hyperlipidemia ranged second place of the results with pooled proportion of 8% (95%CI 5–11%). The third disease was cervical spine disease with pooled proportion of 7%(95%CI 4–12%). Neurasthenia was the fourth common disease with pooled proportion of 6%(95%CI 3–9%). This proportion was same with hypertension, gastric and duodenitis, headaches, vegetable nerve functional disturbance and infection of the upper respiratory tract. The p value of the disease above was all < 0.05 while the p value of egger's test was over 0.05. The poor acceleration was the last disease in table 2 with pooled proportion of 2%(95%CI 2–3%). The other included disease, such as fatty liver, gastric and duodenal ulcers, arrhythmia, ground syncope and urinary calculus, was below 6%, ranging from 3–5%(table 2). Figure 2 representatively showed the forest plots of cervical and lumbar spine disorder. The blue marker demonstrated the proportion extracted from each included records while the red diamond showed the pooled proportion meta-analyzed by metaprop function.

Sub-group analysis was applied according to different investigation year(Table 3). The 2010 was set as the dividing line for sub-analysis of each disease. Cervical and lumbar spine disorder showed proportion of 10% in group of before 2010 while a remarkable increase to 15%(95%CI 9–26%) was found in group of after 2011. The cervical spine disease reported proportion of 5%(95%CI 3–8%) in group of before 2010 while in group of after 2011 the pooled proportion increased to 12%(95%CI 4–38%). The egger's test for both disease was over 0.05 while p value of heterogeneity was < 0.01. The vegetative nerve functional disturbance had higher proportion in the group of before 2010(9%, 95%CI 6–11%) compared with the group of after 2011(3%, 95%CI 2–5%). The fatty liver showed pooled proportion of 2%(95%CI 1–4%)

which raised to 6%(95%CI 5–8%) in the group of after 2011. The arrhythmia showed pooled proportion of 3%(95%CI 2–5%) which grew to 6%(95%CI 3–9%) in the group of after 2011.

Discussion

The disease spectrum of the Chinese crew-members can describe the common disease of the crew-members that is crucial for health management of Chinese crew-members^[9]. However, the disease spectrum is not well documented and lacks consistence between each research paper^[10]. Thus, with poor health management causing by indefinite disease spectrum, the crew-members cannot fulfill the job working in the air. And there is no way to guide properly for health support for aviation doctor. Therefore, the necessary to recognize the most common disease for the crew-members is deeply accepted.

Our results demonstrated that during investigation year from 1958 to 2018, there are 15 common diseases commonly happened in Chinese crew-members. These are cervical and lumbar spine disorder(10%), hyperlipidemia(8%), cervical spine disease(7%), neurasthenia(6%), hypertension(6%), gastritis and duodenitis(6%), headache(6%), vegetative nerve functional disturbance(6%), upper respiratory infection(6%), fatty liver(5%), gastric and duodenal ulcers(4%), arrhythmia(4%), ground syncope(3%), urinary calculus(3%) and poor acceleration tolerance(2%), respectively.

The first common disease was cervical and lumbar spine disorder. There is a consistency that cervical and lumbar was the first common disease in spectrum of Chinese crew-members. Yang et al supported this idea with their results^[6]. The paper of Yang's presented that the first three common disease in the investigation was cervical and lumbar spine disease, hyperlipidemia and fatty liver. The proportion of the disease was 8.03% which means 82 got the diseases out of 1021 subjects. This prevalence is same with our results, 10%(8%-13%). Our previous work had higher results that the two most frequently happened diseases were cervical spondylosis and lumbar disease^[11]. The proportion of these two diseases were 29% and 22% respectfully. Xiuming Wang and colleagues reported the first common disease was lumbar and cervical disease^[12]. Our results reported proportion with 10%. It is between the result of Jiaying Zhou et al and Xiuming Wang.

There might be three reasons for crew-members getting a disc herniation. First, crew-members have to keep a sitting statue for long time, especially for transport plane. Second, the helmet may burden the pressure hold by cervical spine, especially when there is high acceleration^[13]. Third, the plus-minus acceleration may introduce more pressure on spine to fight against the acceleration^[14].

Our sub-analyzed results of cervical and lumbar spine disorder of investigation year supported the third hypothesis. We did subgroup analysis for group of year before 2010 and group of year after 2011. There is an increase of acceleration for Chinese crew-members after 2011. In the group of before 2010 of disease of cervical and lumbar spine disorder, the proportion was 10%, almost same with the proportion in the whole objects. But the proportion in the group of after 2011 increase dramatically to 15%. This might support the third reason for the crew-members spine disease. This might support the idea that with

high acceleration, there is higher proportion of cervical and lumbar spine disorder happened in the crew-members.

The second common disease was hyperlipidemia with proportion of 8%(CI 5–11%). Hongjie Shen and colleagues reported that hyperlipidemia was among the first five diseases in crew-members^[15]. Jishun Yang et al supported this by presenting the results that hyperlipidemia was the second high proportion disease during investigation group^[6]. The reason for this might related to the increase of food calories in crew-members' diets. Therefore, there is great need for aviation doctors focus on hyperlipidemia both on prevention and treatment.

There are other three kinds of trend we would like to discuss in the sub-analysis by investigation year. First, vegetative nerve functional disturbance decreased in the group of after 2011. This might related to diagnosis accuracy. Disease used to be diagnosis with vegetative nerve functional disturbance now was grouped accurately to other diseases. Second, fatty liver increased dramatically in group of after 2011 compared with group of before 2010. This might correlated to the increase of calories in the diet of crew-members with improvement of Chinese economy. Third, arrhythmia also showed high proportion of increase compared with group of before 2010. The proportion was only 2% in group of before 2010. And it increased to 6% in the group of after 2011. This might related to the improvement of diagnostic capability of aviation doctors with the year passing by.

Our work demonstrated the most 15 common diseases for Chinese crew-members. With these results, aviation doctors could focus more on the frequently happened diseases. Also the proportion of other diseases was showed in the results. Our work make a clear vision for future research and aviation work. The disease spectrum of crew-members is the classical way to get started for health management of crew-members. Our investigations also showed the variation of disease spectrum with different investigation year. This could guide research and improvement direction of the health service support in the future.

Limitations

Our results has limitation. Diseases happened for Chinese crew-members but not over 6 reports were not analyzed in our research. These diseases included depression, anxiety, knee joint disease, polyp of gallbladder, aviation disease, hyperuricemia and renal cysts and so on. These diseases also happened in inpatient crew-members and need further analyzed in near future.

Conclusion

Our paper presented all 15 common disease of Chinese crew-members. cervical and lumbar spine disorder was the first frequently happened disease in inpatient crew-members. The proportion of cervical and lumbar spine disorder in crew-members varied according to investigation year. Other diseases were

also showed in meta-analysis work of inpatient crew-members. This disease spectrum could offer proper guide for health management of Chinese crew-members.

Abbreviations

CI

Confidence interval.

Declarations

Authors' contributions

Zhouheng Ye, Tianyi Zhang and Jianchao Liu contributed equally to this work. Zhouheng Ye, Tianyi Zhang and Jianchao Liu conceived the idea and the designed the study. Zhouheng Ye and Tianyi Zhang collected the data. Tianyi Zhang and Jianchao Liu cleaned the data. Zhouheng Ye and Tianyi Zhang draft the manuscript. All authors critically revised the manuscript for important intellectual content. All authors read and approved the final version of the manuscript.

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Availability of data and materials

Not applicable.

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

Authors' information

Zhouheng Ye, Tianyi Zhang and Jianchao Liu are co-first author of this article.

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Tables

Due to technical limitations, table 1 to 3 is only available as a download in the Supplemental Files section.

Figures

Figure 1

selection of studies for inclusion in meta

Figure 2

forest plots cervical and lumbar spine disorder

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [table1Thegeneralcharacteristicsofthe24studies.pdf](#)
- [table2Diseasespectrumofcrewmembers.pdf](#)
- [table3Diseasespectrumofcrewmembers.pdf](#)