PRACA ORYGINALNA

# Direct burden of the cardiovascular disease in patients from a hospital in Guangzhou, China 2006–2015

Obciążenie chorobami układu sercowo-naczyniowego u osób hospitalizowanych w szpitalu w Guangzhou w Chinach, w latach 2006–2015

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## Abstract

**Introduction.** To explore the epidemiological characters of cardiovascular disease (CVD) in patients and to give a certain clues for disease prevention and clinical treatment.

**Material and methods.** We carried out an investigation using retrospective study method by the medical records retrieval system, and extracted the data of inpatients suffered from CVD in a hospital in Guangzhou from 2006 to 2015, including age, gender, disease onset time, clinical diagnosis, hospitalization days, cost and so on.

**Results.** The average admissions per 5 years kept increasing in the study period. Most inpatients suffered from the CVD in December (n = 9288, 9.10%), while least in February (n = 7309, 7.16%). Most of the inpatients were 66–75-years-old (n = 24,891, 24.37%). Gender ratio (male vs. female) of CVD inpatients showed a downward trend came with age. The gender ratio was 1.9 and 0.99 among inpatients below 26-years-old and above 85-years-old, respectively. Most common CVD were ischemic heart diseases (29.46%), cerebrovascular diseases (21.59%) and hypertensive diseases (15.18%). The adjusted hospitalization cost was 4600.30 USD in 2006 and 5473.66 USD in 2006, while the average hospitalization days were 15.63 in 2006 and 9.98 in 2015.

**Conclusions.** More attention should be paid to the middle and elderly people with CVD risk factors, especially the senile women, to reduce the disease burden. The change of gender ratio suggested there may be other significant causes leading to the gender differences besides estrogen.

Key words: disease burden, cardiovascular disease, hospital-based, disease onset time, length of stay, hospitalization cost

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## Introduction

According to the latest report from Chinese center for disease control and prevention, cardiovascular disease (CVD) had overtook the tumors and became the leading cause of deaths from chronic diseases in China in 2015. Meanwhile, China is a developing country with limited per capita medical resource. It is reported that the most CVD occurs in low-income and middle-income countries on a world scale, but little is known about the use of effective primary and secondary prevention medications in these communities [1]. There are also few reports on the situation of hospitalization and status of the economic burden of CVD. Therefore, the purpose of our study was to explore the epidemiologic characters of CVD inpatients and to reveal their changing conditions in a hospital in Guangzhou

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from 2006 to 2015, in order to provide an epidemiologic thread for disease prevention and clinical therapy in cities of developing countries.

## Materials and methods

### Hospital-based data

We screen medical records from the database of a teaching hospital, which had collected information about more than 1,1 billion inpatients. We retrieve the medical records in which the main diagnosis was coded by I00-I99 according to the 10th revision of International Classification of Diseases (ICD) or 390–459 in ICD-9 for records prior to the implementation of ICD-10. Therefore, CVD in this essay was used as a general sense including cardiovascular, cerebrovascular disease and other diseases of circulation system. Cases with available age, gender, disease onset time, clinical diagnosis, hospitalization days and cost were included in this study, excluding the cases of congenital heart diseases. In all, there were 102,122 inpatients suffered from CVD in the study hospital from January 1990 to December 2015. Finally, we identified 102,122 inpatients (1990–2015) for age, gender and onset time analysis, 102,001 inpatients (1991–2015) for admission analysis, and 66,357 inpatients (2006–2015) for disease distribution, hospitalization days and cost analysis in this research. Likewise, hospitalization costs were converted into a single currency for the particular year (2015 USD).

### Ethicsconsent

In this study, we explored the direct disease burden of CVD by reviewing the clinical records from a hospital in Guangzhou. So our study does not require an ethics statement or written informed consents given by patients. We can confirm that the records was anonymous prior to analysis. The ethics committee of the first affiliated hospital of Sun Yat-sen University approved this retrospective study.

### Statistical analysis

The analysis of clinical characteristics were according to a single hospital data. Statistical methods included frequency for categorical variables (age, gender, disease onset time and the main clinical diagnosis) and descriptive analysis for numerical variable (hospitalization days and cost). The disease onset time was grouped into 12 month groups. And the analysis of age constitution were grouped into below 26, six 10-year age groups from 26–85 years to 86 or above, respectively. The gender ratio was calculated dividing male number by female number. In the hospitalization cost analysis process, cost was converted into a single currency for the particular year (2015 in Guangzhou, China). The hospitalization cost was adjusted by calculating with the price inflation rates in Guangzhou during the study period to eliminate the influence of price inflation on hospi-
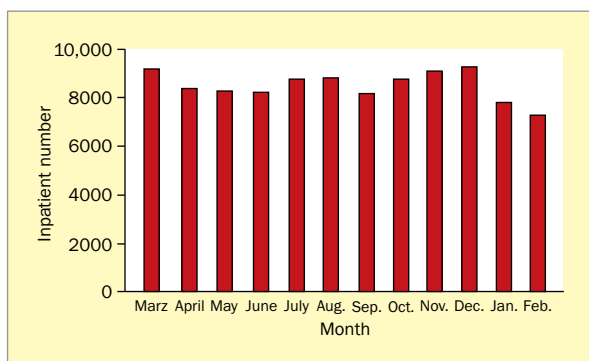


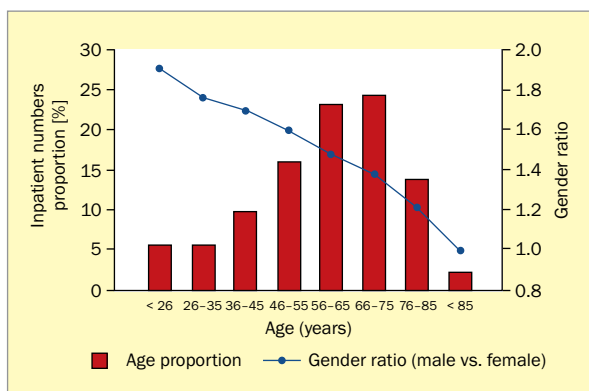**Figure 1.** Average admission distribution by month 1990–2015 (n = 102,122)



**Figure 2.** Age distribution and gender ratio of inpatients month 1990–2015 (n = 102,122)

talization cost. The Statistical analysis was performed using SPSS (version 15.0, SPSS Inc. Chicago, IL, USA).

## Results

### Average admission distribution by month of hospital-based data from 1990 to 2015

According to the Figure 1, it can be seen that most inpatients suffered from CVD in December (n = 9288, 9.10%). The second most inpatients' month was March (n = 9198, 9.01%)whereas the least inpatients' month was February (n = 7309, 7.16%). In summary, there were more CVD inpatients in this hospital at the beginning of winter and spring.

### Age constitution of inpatients and gender ratio of hospital-based data from 1990 to 2015

From Figure 2, we can see that the majority of the inpatients were 66–75-years-old (n = 24,891, 24.37%). The following were 55–65-years-old (n = 23,651, 23.16%) and then 46–55-years-old (n = 16,291, 15.95%). We could learn that the middle age and elderly inpatients (above 45-years-old) were the main source of the admissions, being 79.34%.
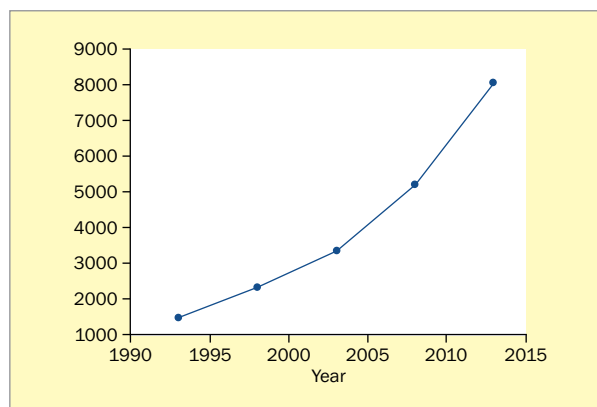
**Figure 3.** Curve of average admissions per 5 years 1991–2015 (n = 102,001)

to dip. It was 1.21 and 0.99 among the 76–85 and above 85-years-old inpatients, respectively. In summary, there were always more men suffered from the CVD than women, but the disease growth rate of women was higher than men. Up to the age above 85-years-old, the gender ratio of the CVD for men and women was almost equal.

## Moving curve of average admission number per five years from 1991–2015

The average admission's numbers per five years were described by this moving curve Figure 3. The average admission's number from 1991 to 1995 was 1479. And average inpatients number of 1996–2000 and 2001–2005 were 2318 and 3332, respectively. Then it soared to 5186 in the next 5 years. And it peaked at 8085 of 2011–2015. So the average admissions per five years kept increasing in the study period.

## Cardiovascular diseases constitution in admissions

According to the Table 1, it can be seen that the ischemic heart diseases accounted for the largest proportion (29.46%). The following were the cerebrovascular diseases (21.59%). Next came the hypertensive diseases

Likewise, it can be seen that the gender ratio (male vs. female) of CVD inpatients showed a downward trend come with age. The highest gender ratio was 1.9 among inpatients below 26-years-old. Then it started to decline, and it decreased to 1.37 among inpatients who were 66–75-years-old. After that, the gender ratio accelerated

**Table 1.** Cardiovascular diseases constitution in admissions 2006–2015

| Diseases | n | Proportion [%] |
|---|---|---|
| Ischemic heart diseases: | 19,548 | 29.46 |
| • angina pectoris | 9700 | 14.62 |
| • chronic ischemic heart disease | 5894 | 8.88 |
| • acute myocardial infarction | 3739 | 5.63 |
| • other acute ischemic heart diseases | 215 | 0.32 |
| Cerebrovascular diseases | 14,326 | 21.59 |
| Hypertensive diseases | 10,073 | 15.18 |
| Cardiac arrhythmias | 5888 | 8.87 |
| Other disorders of the circulatory system | 5734 | 8.64 |
| Rheumatic heart diseases | 2263 | 3.41 |
| Cardiomyopathy diseases | 1934 | 2.91 |
| Non-rheumatic heart valve disorders and endocarditis | 1773 | 2.68 |
| Aortic aneurysm and dissection | 1478 | 2.23 |
| Atherosclerosis | 1295 | 1.95 |
| Pulmonary heart disease and diseases of pulmonary circulation | 574 | 0.87 |
| Other aneurysm | 532 | 0.80 |
| Acute heart failure | 451 | 0.68 |
| Pericardium diseases | 302 | 0.46 |
| Other forms of heart disease | 186 | 0.28 |
| Total | 66,357 | 100.00 |

Notes: in the statistical work, patients with chronic heart failure were counted by their primary disease if there was a clear primary disease leading to the chronic heart failure
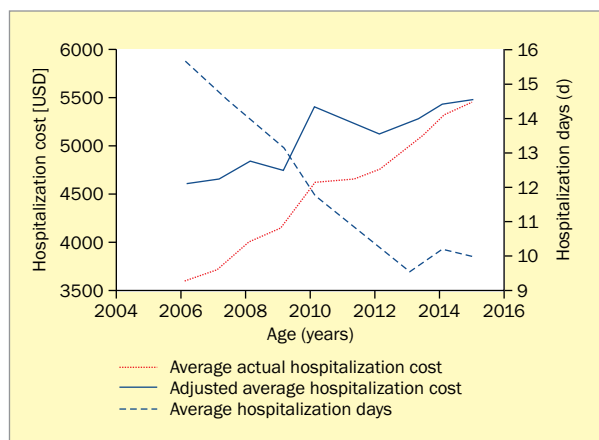
**Figure 4.** Trends of average hospitalization cost and hospitalization days 2006–2015 (n = 66,357)

(15.18%). Cardiac arrhythmias and rheumatic diseases ranked the fourth (8.87%) and the sixth (3.41%), respectively. So the Table suggested that the most common sources of the CVD were ischemic heart diseases, cerebrovascular diseases and hypertensive diseases. Then, we divided the ischemic heart diseases into four more specific kinds of diseases. They were angina pectoris (14.62%), chronic ischemic heart disease (8.88%), acute myocardial infarction (5.63%), and other acute ischemic heart diseases (0.32%).

## Hospitalization cost and the length of stay of cardiovascular diseases

In the analysis process, hospitalization costs were converted into a single currency for the particular year (2015 USD). According to Figure 4, it can be seen that the actual hospitalization cost was 3609.26 dollars in 2006. Then the tangible hospitalization cost kept increasing and peaked to 5473.66 dollars in 2015. Considering the hospitalization cost can be affected by many factors such as new medical technology application and price inflation, we calculate the adjusted hospitalization cost by using the price inflation rates in Guangzhou during the study period to eliminate the influence of price inflation on hospitalization cost. Then we found the regulated hospitalization cost was 4600.30 dollars in 2006. It soared to 4618.46 dollars in 2010. After that it showed a fluctuant trend around 5300 dollars from 2011 to 2015.

Meanwhile, the average length of stay was 15.63 days in 2006. The average length of stay showed a downward trend from 2006 to 2013. It declined to 9.57 days in 2013. Then it fluctuated around 10 days from 2013 to 2015. And it was 9.98 days in 2015.

## Discussion

### Admission number of cardiovascular diseases

Admissions were increasing from 1991 to 2015 in the study hospital. Initially, it was due to an unhealthy living style. For instance, more people in Guangzhou were accustomedto a diet with high levels of salt and oil. Smoking and drinking became more popular than before in the daily life [2]. Likewise, many people working in the office lack of sports. It is reported that among a sample of patients with a coronary heart disease (CHD) or stroke event from countries with varying income levels, the prevalence of healthy lifestyle behaviors was low, with even lower levels in poorer countries [3]. The next reason is the working pressure in the modern society. People, especially the young people, had to work harder because of the working competition, which contributed to the onset of CVD. The following reason was that old people accounted for a large proportion in Guangzhou in recent years, just like many other cities in China. As we know, most risks of CVD are related to aging. Therefore, we could understand there will be more CVD patients in an aging society. Finally, medicine conditions in Guangzhou are improving. People have more knowledge about CVD, and the diagnosis technology is improving. It can make a sense that more CVD can be diagnosed at an early stage than before, and it also led to an increasing admission number in the hospitals [4].

### Monthly admission distribution of cardiovascular disease

According to our study, there were more admissions in the spring and winter in a year. To be specific, the number of admissions was the highest in December, and March ranked second. We can learn that there were more CVD inpatients at the beginning of spring and winter, when the weather was changing. We think there were several reasons. Firstly, the cold weather in the winter will cause blood vessels in the human body to constrict, which is an important cause of CVD. Secondly, people are susceptible to catch a cold in the changeable weather of spring. A cold is an important inducement of many CVD such as heart failure. A latest research suggested that the winter season was associated with a substantially increased risk of cardiovascular death among older Chinese cardiovascular inpatients [5].

### Distribution of cardiovascular disease in admissions

It can be seen that ischemic heart diseases accounted for the largest proportion in the disease constitution in this study. It reveals that the ischemic heart diseases be-

come more common in the modern society. The ischemic heart diseases are one of the most important causes of heart failure and cardiac death. Many countries encounter a similar situation. For example, a research in Greece reveals that the burden of CHD and its related risk factors is at emerging rates making the need for effective public health actions more necessary than ever before in urban Greek population [6].

## Age constitution of inpatients

The middle and elderly patients, especially people who were 66–75-year-old, accounted for the largest proportion of admissions. To begin with, many CVD are degenerative, so they often onset in or after the middle age. On the other hand, many risks of CVD, such as smoking and diabetes mellitus, are more popular in the middle and elderly people. It is evidenced that both early and late onset of diabetes are associated with increased risk of major CHD events and mortality [7].

## Hospitalization cost of cardiovascular diseases

In our study, the hospitalization cost showed an upward trend from 2006–2015. As we know, the hospitalization cost is related to the application of modern medical diagnostic technology, brand new therapy and even the economic inflation. So we calculated with the inflation rate in Guangzhou to reduce the influence of price inflation on hospitalization cost. Then we found that the adjusted cost in 2015 was about 1000 US dollars more than that in 2006. We deem that strengthening the primary and secondary preventions should be implemented to prevent or postpone the CVD, which will be effective in reducing the hospitalization cost [8].

## Length of stay of admissions with cardiovascular diseases

Length of stay of inpatients gradually decreased in the study years. Many factors could affect the hospitalization days, for instance, illness severity [9], clinical complications [10], hospital management level [11], curative technology and so on. It is well known that the hospitalization day concern about the working efficiency and quality of the medical staff. So we can learn that the clinical diagnosis and treatment level of CVD specialty in our hospital is improving. How to further reduce the hospitalization days

while guaranteeing medical quality and safety, is what we should pay attention to in the following days.

## Gender ratio in cardiovascular diseases

In our study, we found that more men suffered from CVD than women, but it was interesting to note that the gender ratio (male vs. female) showed a downward trend from 2006 to 2015. There were many reasons. Firstly, it is easy to understand men were more susceptible to CVD because of unhealthy living style, for example, smoking, drinking and more society pressure. It is reported that inequalities in cardiovascular risk factors by social class were higher among women than among men. Some cardiovascular risk factors such as smoking and obesity showed significant inequalities from a very early age [12]. Secondly, it was reported that the symptoms of CVD were always atypical in female patients, which may lead to fewer female inpatients in the hospital admissions. Thirdly, although there is lack of explicit clinical evidence, it is widely believed that estrogen is an important endogenous protection factor for women being free from the CVD. Likewise, we found that the gender ratio was still declining in premenopausal females. It suggested that there may be many comprehensive factors besides unhealthy male living habits are affecting the gender ratio besides the lifestyle and estrogen. And it deserves more attentions.

## Conclusions

Cardiovascular diseases can greatly affect the life quality. In the coming days, there will be more people suffering from the diseases, especially the coronary heart disease and cerebral apoplexy, because of the aging population. Therefore, the prevention of CVD will play an important role in improving life quality. And more attention should be paid to the middle and elderly women. Our research is a single center study. So the sample size is limited, and its representation are somewhat affected. Meanwhile, this study is a cross-sectional study, and the extended follow-up information of these inpatients is not available at present. It needs further multi-center, long-term follow-up researches.

## Conflict of interest(s)

No authors have any conflict of interest to declare.

## Streszczenie

**Wstęp.** Badanie przeprowadzono w celu oceny cech epidemiologicznych chorych hospitalizowanych z powodu chorób układu sercowo-naczyniowego i sformułowanie wskazówek dotyczących zapobiegania tym chorobom oraz ich leczenia.

**Materiał i metody.** Badanie przeprowadzono w sposób retrospektywny na podstawie analizy danych medycznych, korzystając z dokumentacji pacjentów hospitalizowanych z powodu chorób układu sercowo-naczyniowego w szpitalu w Guangzhou w latach 2006–2015. Dane włączone do analizy obejmowały między innymi wiek, płeć, czas rozpoczęcia choroby, rozpoznanie kliniczne, okres hospitalizacji (dni), koszty związane z hospitalizacją.

**Wyniki.** Średnia liczba hospitalizacji na 5 lat zwiększała się stale w badanym okresie. Najwięcej chorych zgłaszało się do szpitala z powodu chorób układu sercowo-naczyniowego w grudniu (n = 9288; 9,10%), natomiast najmniej w lutym (n = 7309; 7,16%). Największą grupę hospitalizowanych stanowiły osoby w wieku 66–75 lat (n = 24 891; 24,37%). Wartość współczynnika płci chorych (stosunek liczby mężczyzn do liczby kobiet) wśród osób hospitalizowanych z powodu chorób układu sercowo-naczyniowego zmniejszała się z wiekiem. Współczynnik ten wynosił 1,9 i 0,99, odpowiednio, w grupach chorych w wieku poniżej 26 lat oraz powyżej 85 lat. Do najczęstszych CVD należały choroba niedokrwienna serca (29,46%), choroba naczyniowa mózgu (21,59%) i nadciśnienie tętnicze (15,18%). Skorygowane koszty hospitalizacji wynosiły 4600,30 USD w 2006 roku i 5473,66 USD w 2015 roku, natomiast średni czas hospitalizacji wynosił odpowiednio 15,63 i 9,98 dnia.

**Wnioski.** Aby zmniejszyć obciążenie chorobami sercowo-naczyniowymi należy zwrócić większa uwagę na osoby w średnim i podeszłym wieku, u których występują czynniki ryzyka sercowo-naczyniowego; dotyczy to zwłaszcza starszych kobiet. Zmiana proporcji płci chorych sugeruje, że oprócz estrogenu mogą istnieć inne przyczyny powodujące różnicę w liczbie zachorowań na choroby sercowo-naczyniowe.

Key words: disease burden, cardiovascular disease, hospital-based, disease onset time, length of stay, hospitalization cost

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## References

1. Yusuf S, Islam S, Chow CK, et al. Prospective Urban Rural Epidemiology (PURE) Study Investigators. Use of secondary prevention drugs for cardiovascular disease in the community in high-income, middle-income, and low-income countries (the PURE Study): a prospective epidemiological survey. Lancet. 2011; 378(9798): 1231–1243, doi: 10.1016/S0140-6736(11)61215-4, indexed in Pubmed: 21872920.

2. Ohira T, Iso H. Cardiovascular disease epidemiology in Asia: an overview. Circ J. 2013; 77(7): 1646–1652, doi: 10.1253/circj.cj-13-0702, indexed in Pubmed: 23803294.

3. Teo K, Lear S, Islam S, et al. PURE Investigators. Prevalence of a healthy lifestyle among individuals with cardiovascular disease in high-, middle- and low-income countries: the Prospective Urban Rural Epidemiology (PURE) study. JAMA. 2013; 309(15): 1613–1621, doi: 10.1001/jama.2013.3519, indexed in Pubmed: 23592106.

4. Carreras F, Leta R, Pons-Lladó G. Impact of multidetector computed tomography noninvasive coronary angiography on epidemiology: toward direct evidence of cardiovascular risk. Rev Esp Cardiol (Engl Ed). 2013; 66(12): 926–928, doi: 10.1016/j.rec.2013.07.007, indexed in Pubmed: 24774104.

5. Xu B, Liu H, Su N, et al. Association between winter season and risk of death from cardiovascular diseases: a study in more than half a million inpatients in Beijing, China. BMC Cardiovasc Disord. 2013; 13: 93, doi: 10.1186/1471-2261-13-93, indexed in Pubmed: 24172216.

6. Panagiotakos DB, Georgousopoulou EN, Pitsavos C, et al. ATTICA Study group. Ten-year (2002-2012) cardiovascular disease incidence and all-cause mortality, in urban Greek population: the ATTICA Study. Int J Cardiol. 2015; 180: 178–184, doi: 10.1016/j.ijcard.2014.11.206, indexed in Pubmed: 25463360.

7. Wannamethee SG, Shaper AG, Whincup PH, et al. Impact of diabetes on cardiovascular disease risk and all-cause mortality in older men: influence of age at onset, diabetes duration, and established and novel risk factors. Arch Intern Med. 2011; 171(5): 404–410, doi: 10.1001/archinternmed.2011.2, indexed in Pubmed: 21403036.

8. Redfern J, Hyun K, Chew DP, et al. Prescription of secondary prevention medications, lifestyle advice, and referral to rehabilitation among acute coronary syndrome inpatients: results from a large prospective audit in Australia and New Zealand. Heart. 2014; 100(16): 1281–1288, doi: 10.1136/heartjnl-2013-305296, indexed in Pubmed: 24914060.

9. Swaminathan RV, Rao SV, McCoy LA, et al. Hospital length of stay and clinical outcomes in older STEMI patients after primary PCI: a report from the National Cardiovascular Data Registry. J Am Coll Cardiol. 2015; 65(12): 1161–1171, doi: 10.1016/j.jacc.2015.01.028, indexed in Pubmed: 25814223.

10. Weiner RA, El-Sayes IA, Theodoridou S, et al. Early post-operative complications: incidence, management, and impact on length of hospital stay. A retrospective comparison between laparoscopic gastric bypass and sleeve gastrectomy. Obes Surg. 2013; 23(12): 2004–2012, doi: 10.1007/s11695-013-1022-z, indexed in Pubmed: 23846474.

11. Schmidt R, Geisler S, Spreckelsen C. Decision support for hospital bed management using adaptable individual length of stay estimations and shared resources. BMC Med Inform Decis Mak. 2013; 13: 3, doi: 10.1186/1472-6947-13-3, indexed in Pubmed: 23289448.

12. López-González ÁÁ, Bennasar-Veny M, Tauler P, et al. [Socioeconomic inequalities and age and gender differences in cardiovascular risk factors]. Gac Sanit. 2015; 29(1): 27–36, doi: 10.1016/j.gaceta.2014.08.004, indexed in Pubmed: 25438743.