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Article

Trends in the burden of leukemia in China from 2010 to 2021

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Abstract: Leukemia is a major public health problem in China, but epidemiological studies on leukemia in China are still insufficient. This study aims to analyze leukemia's disease burden and risk factors in China from 2010 to 2021 and provide a basis for leukemia prevention and treatment. Using data from the Global Burden of Disease (GBD) database, trends in the burden of leukemia in China from 2010 to 2021 were analyzed. Additionally, epidemiological differences by gender and age groups were explored. In 2021, there were 531,000 leukemia patients in China, with 106,000 new cases and 59,000 deaths. Compared to 2010, the mortality rate and disability-adjusted life years (DALYs) per 100,000 population in 2021 decreased by 5% and 18%, respectively, while the incidence and prevalence rates increased by 12% and 29%, respectively. Gender and age stratification indicated that males had higher rates across all indicators than females, and elderly individuals faced higher leukemia mortality and DALYs. The most significant decrease in DALYs was observed in children and adolescents under 20. The highest burden of leukemia for males was found in the 85–90 age group, while for females, it was in the 70–74 age group. Major risk factors for leukemia included smoking, high BMI, and exposure to carcinogens, benzene, and formaldehyde. The overall burden of leukemia in China showed a decreasing trend, with significant gender and age differences. More measures are needed to reduce leukemia mortality, particularly focusing on the prevention and treatment of leukemia in males and the elderly.

Keywords: leukemia; disease burden; GBD; mortality; DALYs

1. Introduction

Leukemia is a malignant clonal disorder originating from hematopoietic stem cells and is currently the tenth leading cause of cancer-related deaths globally (Sung et al., 2021). Early studies indicate that high-income countries have higher cure rates, while middle-income countries experience higher mortality rates (Abboud et al., 2014; Abdelmabood et al., 2020). In China, approximately 141,317 new cases of leukemia and 60,010 deaths were reported in 2017, accounting for 27.3% of the global new cases and 17.3% of the global deaths (Li et al., 2020). Leukemia has become a significant public health issue in China, posing a severe threat to the health and lives of its population. Additionally, the pathogenesis of leukemia is complex, and its incidence varies by age, gender, and race (Lim et al., 2014). However, epidemiological studies on leukemia in China remain insufficient, primarily focusing on specific cities, with a lack of large-scale research.

Previous studies have found that men and the elderly are more likely to develop leukemia. More men than women are diagnosed with leukemia and die from the disease. Approximately 30% more men than women are affected by leukemia (Jackson et al., 1999). Compared with younger patients, older AML patients often face more complications and treatment challenges, severely affecting prognosis and shortening life expectancy (Huang and Olin, 2017; Sekeres et al., 2020). In addition, environmental exposure and lifestyle habits have also been found to be associated with the occurrence of leukemia. Although the exact cause of leukemia is not fully understood, environmental factors such as exposure to chemicals and radiation are associated with an increased risk of developing the disease (Bispo et al., 2020; Poynter et al., 2017). Some studies have shown that exposure to formaldehyde can adversely affect the hematopoietic system and may lead to leukemia (Kwon et al., 2018; Zhang et al., 2010). Heavy metals produced by human activities such as industrial engineering, automobile exhaust, and cigarette smoke can produce stable biotoxic compounds when they enter the human body. These compounds disrupt biological processes, interfere with human functions, and cause various cancers in the human body (Lafta et al., 2024). The imbalance of urban and rural development is a long-standing phenomenon in China. Compared with urban residents, rural residents are more likely to be exposed to ionizing radiation and chemical substances such as benzene and formaldehyde, which further widens the gap in leukemia mortality between urban and rural areas (Li et al., 2020). Therefore, it is necessary to study the trends and influencing factors of leukemia mortality in China by gender and age group to understand better and solve this urgent healthcare problem.

The Global Burden of Diseases, Injuries, and Risk Factor Study (GBD) study provides epidemiological data on 369 diseases and injuries, stratified by gender, age, country, and region (Yang et al., 2024). This study aims to comprehensively assess leukemia's current burden and trends in China from 2010 to 2021 by collecting epidemiological indicators such as prevalence, incidence, and mortality. Additionally, it seeks to explore the risk factors influencing the development of leukemia, thereby providing a reference for the prevention and treatment of the disease.

2. Materials and methods

2.1. Data sources

The data for this study were obtained from the GBD 2021. The GBD provides epidemiological data and disease burden assessments for 369 diseases and injuries, and 87 risk factors across 204 countries and regions. The original data were sourced from regional censuses, surveys, demographic data, and other health-related databases.

2.2. Research methods

Epidemiological data on leukemia in China in 2010 and 2021 were extracted from the GBD 2021 database. The epidemiological indicators analyzed included prevalence, incidence, mortality, disability-adjusted life years (DALYs), years of life lost (YLLs), and years lived with disability (YLDs). The leukemia burden in China in 2021 and the changes in this burden from 2010 to 2021 were analyzed across the general population, different gender groups, and age groups.

2.3. Statistical methods

The prevalence, incidence, mortality, DALYs, YLLs, and YLDs for leukemia in China in 2010 and 2021 were first extracted to describe the current burden of leukemia.

Line charts were used to illustrate the epidemiological trends from 2010 to 2021. Gender-specific and age-specific stratifications were employed to further explore and compare the changes in leukemia burden across different demographic groups. A bidirectional bar chart was utilized to present the leukemia burden across different genders and age groups in China in 2019. Finally, an analysis of leukemia risk factors in China in 2010 and 2021 was conducted. Graphs were generated using the ggplot2 package in R.

3. Results and discussion

3.1. Epidemiological trends of leukemia in China (2010–2021)

From 2010 to 2021, the incidence and prevalence of leukemia in China showed an increasing trend. Compared to 2010, leukemia cases increased by 37% in 2021, and the proportion of leukemia patients in all patients in China increased by 29%. However, the proportion of leukemia deaths among all-cause mortality decreased by 16%, and the mortality rate per 100,000 population declined by 5%. DALYs due to leukemia in China were 2542.46 in 2010 and reduced to 2205.22 in 2021, representing a 13% decrease. Among these, YLLs decreased by 14%, while YLDs increased by 34% (**Table 1**).

Table 1. Leukemia burden in China from 2010 to 2021.

Index	2010	2021	Percentage change
Prevalence			
Number	387.46 (448.69 to 290.54)	531.66 (665.15 to 352.73)	0.37 (0.12 to 0.67)
Percent	0.03% (0.04% to 0.02%)	0.04% (0.05% to 0.03%)	0.29 (0.05 to 0.57)
Rate	28.98 (33.56 to 21.73)	37.37 (46.75 to 24.79)	0.29 (0.05 to 0.57)
Incidence			
Number	88.58 (101.29 to 66.17)	105.67 (132.24 to 75.28)	0.19 (−0.01 to 0.44)
Percent	0% (0% to 0%)	0% (0% to 0%)	0.12 (−0.07 to 0.35)
Rate	6.63 (7.58 to 4.95)	7.43 (9.29 to 5.29)	0.12 (−0.07 to 0.36)
Death			
Number	58.14 (66.39 to 45.26)	58.9 (74.04 to 43.63)	0.01 (−0.17 to 0.23)
Percent	0.6% (0.68% to 0.47%)	0.5% (0.58% to 0.38%)	−0.16 (−0.21 to −0.09)
Rate	4.35 (4.97 to 3.39)	4.14 (5.2 to 3.07)	−0.05 (−0.22 to 0.15)
DALYs			
Number	2542.46 (2888.69 to 1973.61)	2205.22 (2736.62 to 1612.84)	−0.13 (−0.28 to 0.04)
Percent	0.69% (0.8% to 0.53%)	0.55% (0.67% to 0.4%)	−0.2 (−0.28 to −0.11)
Rate	190.17 (216.07 to 147.62)	155 (192.35 to 113.36)	−0.18 (−0.32 to −0.02)
YLLs			
Number	2497.09 (2835.33 to 1937.09)	2144.45 (2652.41 to 1567.54)	−0.14 (−0.29 to 0.03)
Percent	1.03% (1.17% to 0.81%)	0.87% (1% to 0.65%)	−0.16 (−0.23 to −0.07)
Rate	186.78 (212.08 to 144.89)	150.73 (186.43 to 110.18)	−0.19 (−0.33 to −0.03)

Table 1. (*Continued*).

Index	2010	2021	Percentage change
YLDs			
Number	45.37 (61.72 to 30.9)	60.78 (86.18 to 37.86)	0.34 (0.1 to 0.62)
Percent	0.04% (0.04% to 0.03%)	0.04% (0.05% to 0.03%)	0.1 (−0.09 to 0.33)
Rate	3.39 (4.62 to 2.31)	4.27 (6.06 to 2.66)	0.26 (0.03 to 0.52)

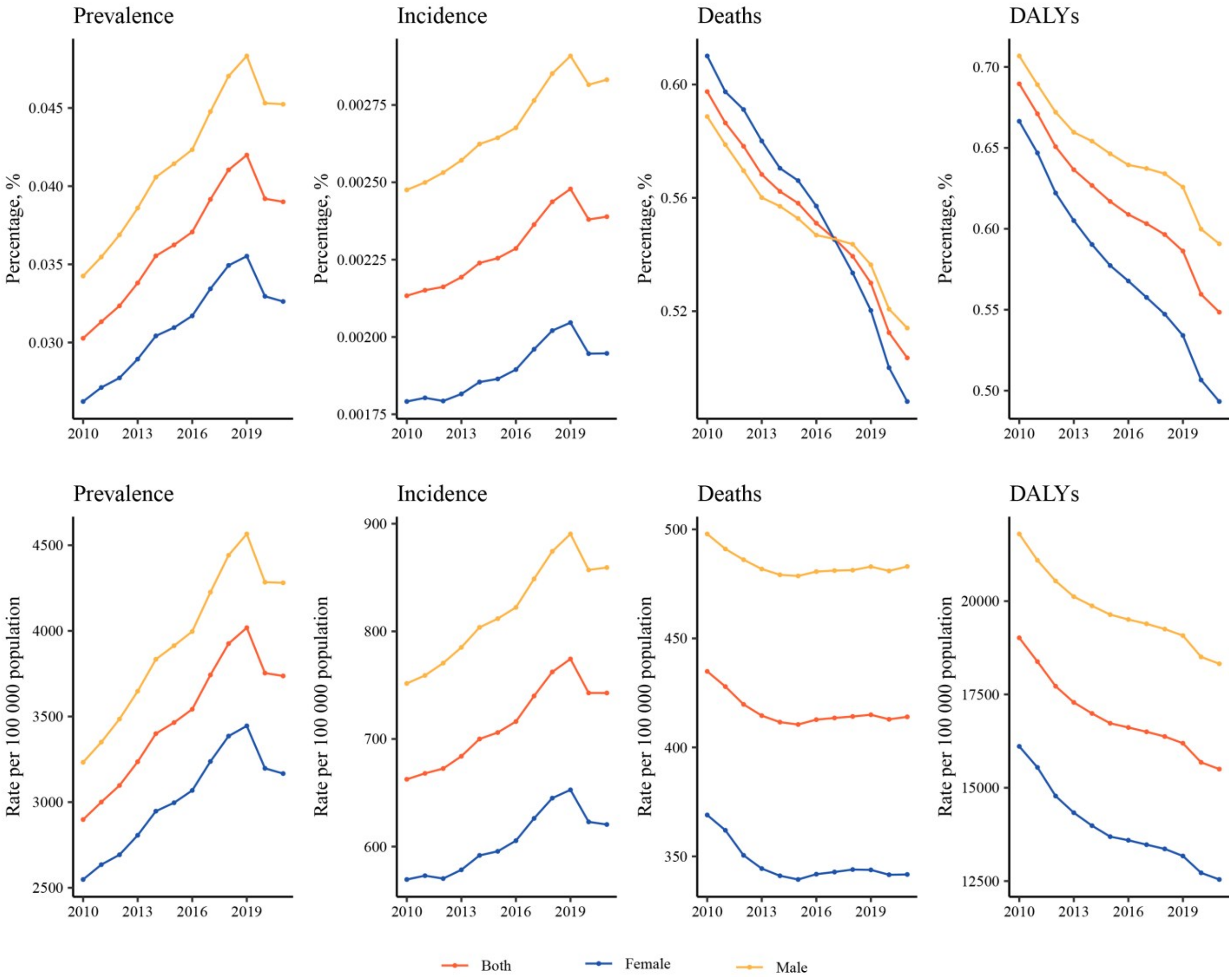

Figure 1. Changes in the prevalence, incidence, mortality, and DALYs of leukemia in China from 2010 to 2021.

As illustrated in **Figure 1**, from 2010 to 2019, both the overall incidence and prevalence rates of leukemia in China increased, reaching a peak prevalence of 4018 per 100,000 population in 2019, with a higher prevalence in males (4566 per 100,000) compared to females (3445 per 100,000). From 2019 to 2021, a slight decrease in prevalence was observed. The proportion of leukemia deaths among all-cause mortality gradually decreased from 2010 to 2021, with a greater reduction observed in females. The mortality rate per 100,000 population declined between 2010 and 2015, remaining stable thereafter. Both the DALY rate and the proportion of DALYs attributable to leukemia showed a downward trend from 2010 to 2021. Overall, the leukemia burden in China exhibited a declining trend during this period, with a higher burden observed in males compared to females.

3.2. Age distribution of leukemia patients in China

The highest incidence rates of leukemia were observed in individuals aged 55 and above, followed by children and adolescents under 20, with the lowest rates in those aged 20 to 54. From 2010 to 2021, the incidence rate for individuals over 20 remained relatively stable with a slight increase, while a significant increase was observed for those under 20 until 2018, followed by a noticeable decrease after 2019. The prevalence rate for those over 20 showed an annual increase, whereas for those under 20, it increased until 2018 and significantly decreased thereafter. In terms of mortality rates, a decline was seen in individuals under 20 and those over 55, while the rates for the 20 to 54 age group remained stable. The proportion of leukemia deaths among all-cause mortality did not change significantly for those under 54, but for those over 55, an increase was observed post-2016. The DALY rates showed a decreasing trend across all age groups, with the most significant reduction in children and adolescents under 20 (**Figure 2**).

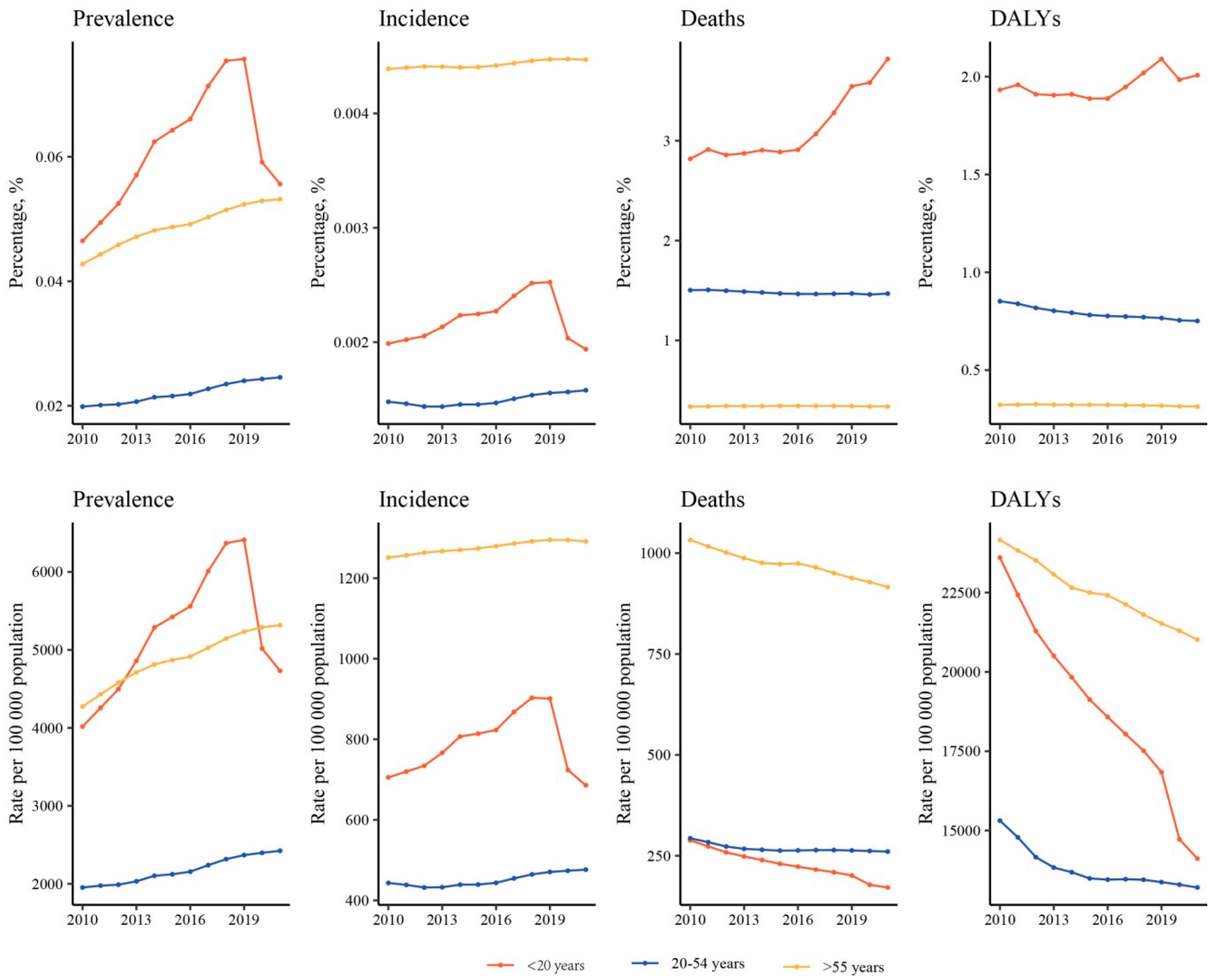

Figure 2. Changes in leukemia prevalence, incidence, mortality, and DALYs among people of different age groups in China from 2010 to 2021.

A more detailed age and gender analysis for 2021 revealed that the highest prevalence rate was among children under 5, with rates of 146 per 100,000 for males and 115 per 100,000 for females. High incidence rates were also noted in this age group, lower rates were seen between ages 5 to 50, after which the incidence increased with age. The highest incidence rate for males was in the 90–94 age group, and for females, it was in the 75–79 age group. Mortality rates increased with age, peaking at 90–94 for males and above 95 for females. The DALYs indicated a higher overall leukemia burden in males, particularly in those over 70, with the highest burden in the 85–90 age group for males and the 70–74 age group for females (**Figure 3**).

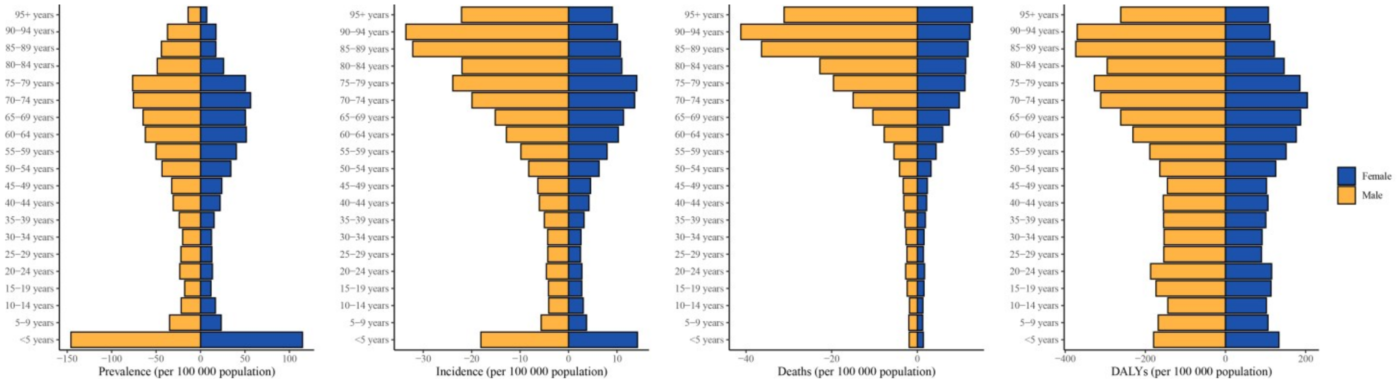

Figure 3. Comparison of leukemia prevalence, incidence, mortality, and DALYs in different age groups in China in 2021.

3.3. Risk factors for leukemia in China

Comparing 2010 and 2021, the top five risk factors for leukemia in China remained smoking, high BMI, exposure to carcinogens, benzene exposure, and formaldehyde exposure. From 2010 to 2021, leukemia cases due to smoking, carcinogen exposure, benzene exposure, and formaldehyde exposure slightly decreased, while those due to high BMI increased (**Table 2**).

Table 2. Changes in the main risk factors for leukemia in China in different years.

	Risk factors	Standardized DALYs rate
2010		
1	Smoking	9.61 (3.55–15.66)
2	High BMI	7.52 (5.42–9.99)
3	Occupational carcinogens	2.22 (1.16–3.27)
4	Occupational exposure to benzene	1.49 (0.42–2.53)
5	Occupational exposure to formaldehyde	0.75 (0.54–0.94)
2021		
1	Smoking	8.68 (3.28–15.05)
2	High BMI	7.82 (5.25–10.83)
3	Occupational carcinogens	2.14 (1.07–3.27)
4	Occupational exposure to benzene	1.45 (0.41–2.56)
5	Occupational exposure to formaldehyde	0.71 (0.49–0.93)

4. Discussion

4.1. Decreasing trend of leukemia burden in China, with higher burden in males and the elderly

The findings of this study indicate a decreasing trend in the mortality rate and DALYs of leukemia in China from 2010 to 2021, consistent with other studies (Li et al., 2020; Wang et al., 2019). However, the incidence and prevalence rates increased, and the disability burden remained significant.

The burden of leukemia in China showed distinct gender and age differences. Both males and females experienced a decreasing trend in leukemia burden, but post-2015, no significant reduction in mortality rates was observed. The overall burden was higher in males, reflected in higher incidence, prevalence, mortality rates, and DALYs compared with females. Similar gender differences have been reported in other studies. For example, a study in the United States estimated 13,150 male and 9690 female leukemia deaths in 2019 (Siegel et al., 2019). In the European Union, male leukemia mortality in 2011 was 4.57 per 100,000 compared to 2.78 per 100,000 for females (Malvezziet et al., 2016). A study in Korea found male leukemia mortality in 2015 to be 3.9 per 100,000 compared to 2.8 per 100,000 for females (Jung et al., 2018). These studies indicate gender differences in leukemia mortality across both high-income and low-to-middle-income countries.

Age-specific trends also varied, with all age groups showing a decrease in leukemia burden. The most significant reduction was observed in children and adolescents under 20, yet this group had the highest proportion of leukemia deaths among all-cause mortality, which increased over time. The highest burden was observed in individuals over 55, with higher incidence, mortality rates, and DALYs compared to other age groups. Poor prognosis in elderly leukemia patients has been noted in other studies as well (Hemminki et al., 2024; Mannelli et al., 2024). Given China's aging population, enhancing social security mechanisms and optimizing healthcare resource allocation are critical to addressing leukemia prevention and treatment in the elderly.

4.2. Smoking, high BMI, and environmental exposures as major risk factors for leukemia

Smoking remained the leading risk factor for leukemia in China in both 2010 and 2021, consistent with other studies (Chen et al., 2023). A cross-sectional analysis found that smoking was associated with decreased overall survival after adjusting for other potential confounders (Kumar et al., 2023). Parental smoking has also been linked to an increased risk of acute myeloid leukemia in children (Frederiksen et al., 2020), further corroborating the health risks of smoking. Additionally, tobacco smoke is a major potential source of benzene exposure, another significant risk factor for leukemia. Several studies have reported a significant association between benzene exposure and the incidence of acute myeloid leukemia (Khalade et al., 2010; Lamm et al., 2009). Formaldehyde exposure has also been linked to increased leukemia risk, with a meta-analysis indicating a higher leukemia risk among workers with occupational formaldehyde exposure (Schwilk et al., 2010). Compared to females,

males generally have higher tobacco consumption and a greater proportion of occupations involving exposure to benzene and formaldehyde, potentially explaining the higher leukemia burden in males.

High BMI was identified as another significant risk factor for leukemia. A meta-analysis indicated that higher BMI at leukemia diagnosis was associated with lower survival rates in children (Orgel et al., 2016). Obesity has become a serious global health issue, and the use of corticosteroids like dexamethasone during leukemia treatment can contribute to obesity. A multicenter cohort study of 1070 children in Mexico found that overweight/obesity was a significant predictor of early death (Núñez-Enríquez et al., 2019). Thus, early interventions, including weight and height monitoring and dietary assessment during leukemia treatment, may help improve patient prognosis.

5. Conclusion

This article used GBD 2021, a very representative database in the field of disease burden research, to conduct an in-depth study of the changing trend and current status of leukemia disease burden in China through stratified analysis, providing data support for China's leukemia prevention and control work. In summary, from 2010 to 2021, the overall leukemia burden in China showed a decreasing trend, with noticeable gender and age differences, particularly affecting males and the elderly. Smoking, high BMI, and exposure to benzene and formaldehyde were identified as major risk factors. Enhancing health education, implementing tertiary prevention, and addressing occupational exposure risks among high-risk populations could further improve the leukemia burden in China. Continued epidemiological and experimental research is needed to explore the risk factors and preventive measures for leukemia.

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