



Published in final edited form as:

*Diabetes Care*. 2021 May ; 44(5): e93–e94. doi:10.2337/dc21-0072.

## Trends in Nontraumatic Lower-Extremity Amputation Among Privately Insured Adults With Diabetes in the U.S., 2004–2018

Xilin Zhou,

Linda J. Andes,

Deborah B. Rolka,

Giuseppina Imperatore,

Stephen R. Benoit

Division of Diabetes Translation, Centers for Disease Control and Prevention, Atlanta, GA

Estimates based on the National Inpatient Sample (NIS) showed that diabetes-related nontraumatic lower-extremity amputation (NLEA) rates declined among hospitalized patients between 2000 and 2009, followed by an increasing NLEA rate between 2009 and 2015 (1). The increase was largely observed in young and middle-aged adults (1). However, the NIS dataset includes only inpatient admissions; minor amputation surgeries that were performed in ambulatory settings were not included in these estimates. In addition, NIS data are event-based, and multiple amputations in the same person are considered as a new event each time. In the current study, we used the IBM MarketScan Commercial Database to examine NLEA occurring in inpatient and outpatient settings among privately insured adults 18–64 years of age with diabetes.

The study period is from 2004 to 2018. People with diabetes and NLEA were identified using the International Classification of Diseases and the Current Procedural Terminology codes. NLEAs were categorized as major (amputations above the foot) or minor (foot and toe amputations) (1). For people who had multiple amputations in a year, we assigned the level of amputation based on the highest level of amputation they had in that year. The annual NLEA rate was calculated as the number of people with NLEA per 1,000 in the study population. The NLEA rates were adjusted using the direct method by sex and age group (18–44, 45–54, 55–64 years), using the sex and age distribution in 2004 MarketScan. We used Joinpoint Trend Analysis Software Version 4.5.0.1 to analyze trends in annual NLEA rates (2). This software uses permutation tests to find points where the trend changes significantly and calculates the annual percentage change (APC) for each segment of the trend.

Readers may use this article as long as the work is properly cited, the use is educational and not for profit, and the work is not altered. More information is available at <https://www.diabetesjournals.org/content/license>.

Corresponding author: Xilin Zhou, [kqt5@cdc.gov](mailto:kqt5@cdc.gov).

**Author Contributions.** X.Z. designed the research, prepared and analyzed data, interpreted results, and drafted the manuscript. D.B.R., G.I., and S.R.B. provided important intellectual content to the manuscript. S.R.B. made a critical revision of the manuscript. L.J.A. advised on coding and identification of health conditions. X.Z. is the guarantor of this work and, as such, had full access to all the data in the study and takes responsibility for the integrity of the data and accuracy of the data analysis.

**Duality of Interest.** No potential conflicts of interest relevant to this article were reported.

Among privately insured adults with diabetes, the sex- and age-adjusted NLEA rate per 1,000 people decreased from 2.47 in 2004 to 1.77 in 2007 (APC =  $-11.26\%$ ,  $P < 0.05$ ) (Fig. 1A), remained stable between 2007 and 2013, and then increased by 27% from 1.72 per 1,000 in 2013 to 2.19 per 1,000 in 2018 (APC =  $5.27\%$ ,  $P < 0.05$ ). Trends differed for major and minor NLEAs. The major NLEA rate decreased by 60% from 2004 to 2010 and then plateaued. The minor NLEA rate influenced the total NLEA rate, decreasing from 2004 to 2007, stabilizing until 2013, and subsequently increasing by 32% thereafter.

Within subpopulations, the NLEA rate for men was more than twice the NLEA rate for women for all years (Fig. 1B). Trends also differed by sex. For men, the NLEA rate decreased by 37% between 2004 and 2010 and then increased by 42% onward, whereas for women, the NLEA rate decreased by 32% between 2004 and 2008 and then remained relatively stable, leading to an increasing gender gap after 2009. The NLEA rate was also larger in older age-groups (Fig. 1C). People aged 55–64 years were twice as likely to have NLEA compared with those aged 18–44. Moreover, the NLEA rate was consistently higher among men than women for all age-groups (Fig. 1D). The youngest male age-group had a higher NLEA rate than the oldest female age-group.

Our study extends current knowledge with more recent data and focused on the privately insured nonelderly population in both inpatient and outpatient settings. We identified several notable patterns. First, the resurgence of the diabetes-related NLEA rate in this group occurred later than that found in NIS (1) and Medicare (3) (2013 vs. 2009). Second, although the rebound was later, the APC was larger in our sample compared with Medicare (APC 5.3% vs. 1.2%) and was similar to that found in NIS (APC 5.8%). Third, our rate estimates were lower than the estimates from NIS, even when compared with the same age-specific rates. For example, among adults aged 45–64 years, the diabetes-related NLEA rate was 5.43 per 1,000 in 2015 from NIS, whereas our estimate was approximately half of that. A possible explanation is that our study population consisted of working, insured adults who may be comparatively healthier and have better access to health care. Also, NIS data are event rather than person based, which could drive up rates if a significant proportion of the population had multiple amputations.

We found that the recent increase in NLEA rates among privately insured adults with diabetes was driven by minor amputations and men aged 45–64 years old. Our study corroborates the findings of previous studies and potentially helps target resources and policy interventions to reduce these preventable complications.

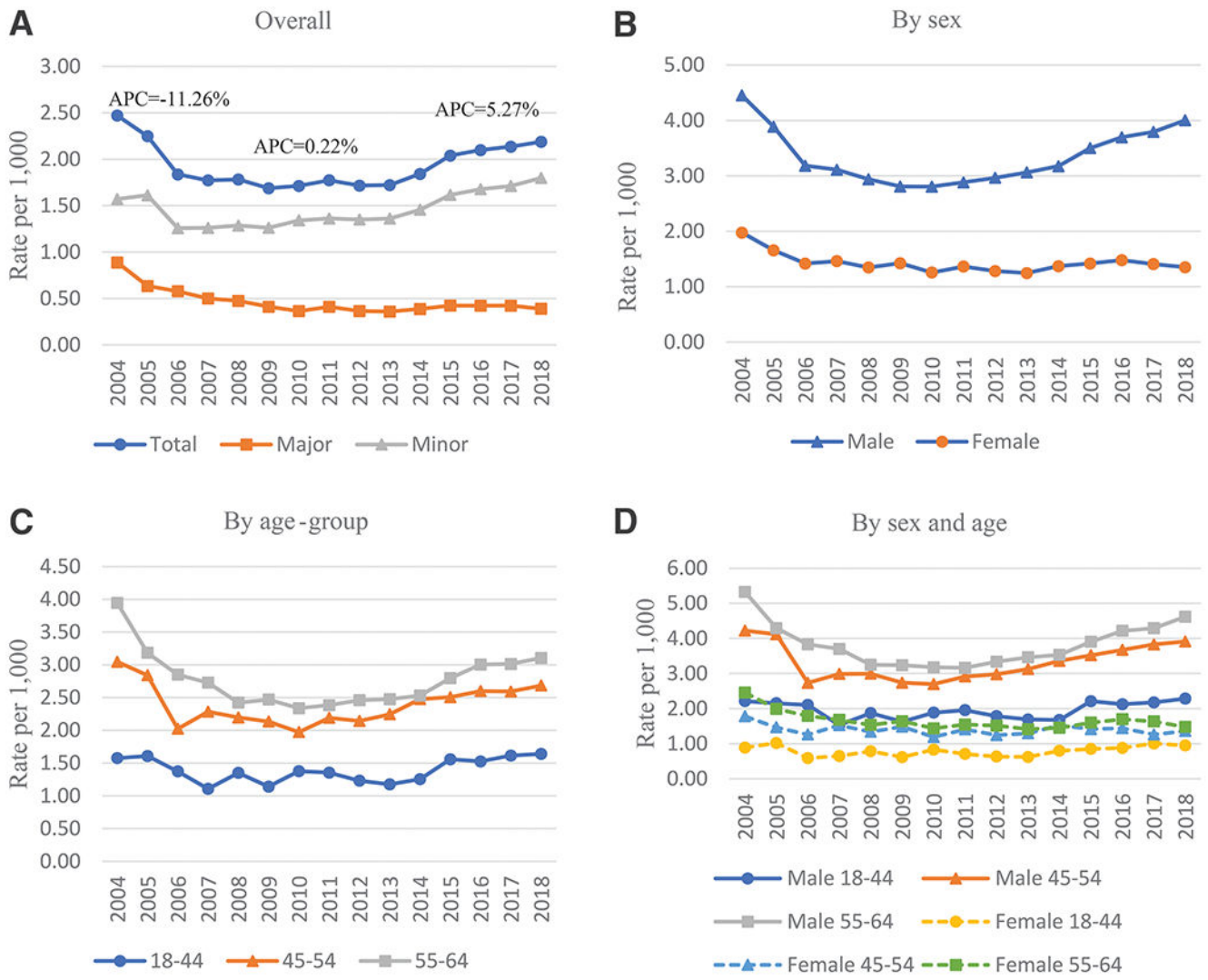
## Acknowledgments.

The authors thank Sundar S. Shrestha for sharing helpful information on the data structure.

The findings and conclusions are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

## References

1. Geiss LS, Li Y, Hora I, Albright A, Rolka D, Gregg EW. Resurgence of diabetes-related nontraumatic lower-extremity amputation in the young and middle-aged adult U.S. population. *Diabetes Care* 2019;42:50–54 [PubMed: 30409811]
2. National Cancer Institute. Joinpoint trend analysis software. Accessed 16 December 2019. Available from <https://surveillance.cancer.gov/joinpoint/>
3. Harding JL, Andes LJ, Rolka DB, et al. National and state-level trends in nontraumatic lower-extremity amputation among U.S. Medicare beneficiaries with diabetes, 2000–2017. *Diabetes Care* 2020;43:2453–2459 [PubMed: 32723844]



**Figure 1—**  
 Rates of nontraumatic lower-extremity amputation among adults 18–64 years of age with diabetes, IBM MarketScan Research Databases, 2004–2018.