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Incidence of first-ever transient ischemic attack in Eastern Finland

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Objectives: The incidence of stroke has been declining in Finland, as well as in Europe. However, it is unclear whether the incidence of transient ischemic attack (TIA) is also decreasing. In fact, the TIA incidence in the Finnish population has never been reported. Therefore, here we investigated the incidence of TIA in the Eastern Finnish population in 2017.

Materials and Methods: All patients with suspected TIA, from a defined catchment area, were referred to a neurological emergency unit at Kuopio University Hospital (KUH) in the Northern Savonia region of Eastern Finland, which had a population of 246,653 in 2017. The original study population comprised TIA patients diagnosed based on the WHO TIA criteria in 2017. Incidence rates were calculated by dividing the number of TIA cases by the number of people in different age groups.

Results: Among 432 patients with a suspected TIA referred to the neurological emergency unit at Kuopio University Hospital in 2017, 293 were living in Northern Savonia and were ultimately diagnosed with TIA after neurological examinations. The number of first-ever TIAs was 211. The crude incidence of all TIA was 122/100,000 inhabitants, and of first-ever TIA was 86/100,000. The age-standardized incidence (European population 2010) of the first-ever TIA was calculated to be 64/100,000. The mean age of first-ever TIA patients was 70 years: 72 years for women versus 68 years for men.

Conclusions: We found a high incidence of TIA in Eastern Finland.

KEYWORDS

epidemiology, incidence, transient ischemic attack

1 | INTRODUCTION

Despite the decreasing mortality rates associated with stroke over recent decades—in 2019, stroke was still the second most common cause of death worldwide, and has caused approximately 11% of total deaths.^{1,2} In Finland, stroke prevalence has been 1.5% within the national population, and the annual stroke incidence (including both ischemic and hemorrhagic stroke) varied between 10,225 and 10,763 during 1999–2007, based on the PERFECT Stroke database.³ From 1999 to 2013, the age-standardized incidence of ischemic

stroke (IS) decreased from 259 to 199 per 100,000 in Finland, and from 283 to 188 per 100,000 in the Northern Savonia region of Eastern Finland.⁴ From 1988 to 1997, among Finnish adults aged 25–74 years, the age-standardized incidence of first-ever ischemic stroke in Eastern Finland (Kuopio area) declined from 289 to 182 per 100,000 among men, and from 158 to 99 per 100,000 among women, whereas no significant decline occurred in Western Finland (Turku area).⁵ In terms of the incidence of ischemic stroke, Western Finland (Turku) is a low incidence area, while Eastern Finland (Kuopio area) is a high incidence area.⁶

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Transient ischemic attack (TIA) is often the precursor of ischemic stroke.^{7,8} The incidence of TIA has shown a stable or weak and statistically insignificant upward trend in Oxford (England), Novosibirsk (Russia), and Dijon (France).^{9–11} Among these recent studies in European countries, the incidence of first-ever TIA ranged from 11.14 to 76 per 100,000—being lowest in Dijon, France (2000–2004) and highest in Northern Portugal (2009–2011)—and the overall incidence of all TIA was 71.5–111 per 100,000. Table 1 presents the incidence rates of first-ever TIA, according to WHO criteria, reported in European countries.^{9–18} In the traditional definition based on WHO criteria, TIA is defined as a focal neurological dysfunction caused by ischemia in the central nervous system, lasting <24 h.¹⁹ In 2002, a new TIA definition was proposed.²⁰ In 2009, the American Heart Association/American Stroke Association (AHA/ASA) presented tissue-based TIA criteria, in which TIA is defined as a temporary ischemic dysfunction causing transient neurological symptoms lasting under 1 h, and without signs of brain damage. For these tissue-based criteria, the recommended neuroimaging is diffusion-weighted MRI

(DWI).²¹ On average, 27.6%–34.3% of TIA patients exhibit tissue-positive findings on DWI.^{22,23} In a Canadian study, DWI lesions were observed in 55.5% of patients with high-risk TIA or minor stroke.²⁴ According to tissue-based criteria, DWI is recommended for TIA diagnosis, since head CT is not sufficiently sensitive to recognize all minor ischemic lesions.²¹ Most TIA incidence reports from the European population or hospital-based cohorts have used the WHO criteria.

The TIA incidence in Finland has never previously been published. Here we report the incidence of TIA in the Eastern Finnish population during 2017. Our hypothesis was that the TIA incidence in Eastern Finland is as high as, or higher than, previously reported in European countries.

2 | MATERIALS AND METHODS

We performed a hospital-based study. The population of the Northern Savonia region was 246,653 citizens in 2017, according to

TABLE 1 Standardized incidence rates of first-ever TIA per 100,000 person-years in different studies

Study	Study period	Study type	Mean age, years	TIA definition	Age-standardized incidence
Oxfordshire, UK ⁹	1981–1986	Population-based	69.4	WHO	42 (1)
	2002–2004		-		58 (2)
Dijon, France ¹¹	1985–1989	Population-based registry	-	WHO	11.72 (3)
	2000–2004		-		11.14 (3)
Novosibirsk, Russia ¹⁰	1987–1988	Prospective population-based registry	62.3 (m)	WHO	17 (4)
	1996–1997		66.5 (f)		27 (4)
Northern Portugal ¹⁵	1998–2000	Prospective community-based registry	72	WHO	67 (5) 65 (without TIA before stroke) (5)
	2009–2011		72		76 (5) 69 (without TIA before stroke) (5)
Spain ¹⁷	2006	Prospective population-based	-	WHO	29 (5)
Århus, Denmark ¹²	2007–2008	Prospective population-based	66.3	WHO	72.2 (including TIA before stroke) (6) 52.4 (6)
Friuli Venezia Giulia, Italy ¹³	2007–2009	Population-based	76.4	WHO	25 (6)
Joinville, Brazil ³²	2009–2010	Population-based	61.6 (definite)	WHO	14 (definite) 28 (probable and definite cases) (5)
Sweden ¹⁶	2011–2012	Hospital-based	71.4	WHO	73 (7) 47 (4)
Auckland, New Zealand ³¹	2011–2012	Population-based	71.5	WHO	40 (8)
L'Agila, Italy ¹⁸	2011–2012	Prospective population-based registry	73.3	WHO	28.6 (9)
				ASA	20.0 (9)
Tandil, Argentina ³⁰	2013–2015	Prospective population-based	-	WHO	59.3 (7)

Note: (1) England and Wales population 1981; (2) England and Wales population 2001; (3) World population; (4) European population 1976; (5) European population; (6) European standard population; (7) European population 2013; (8) WHO world population; (9) European population 2011. Abbreviations: ASA, American Stroke Association; f, female; m, male.

Statistics Finland.²⁵ Within this region, all TIA diagnostic examinations are carried out at the neurological emergency unit of Kuopio University Hospital (KUH). All patients with a suspected TIA within 2 weeks before admission are referred to KUH—with the exception that patients with a suspected TIA living in permanent nursing homes may not be sent to KUH.

A total of 432 patients were identified from the patient data system of KUH, through a search using the diagnosis codes G45.0–45.9 from the International Classification of Diseases, Tenth Revision (ICD-10). The included hospital admissions were from January 1st through December 31st in 2017. Patients with transient global amnesia (ICD-10-code G45.4) and patients treated at KUH but living in other hospital districts were excluded from the analyses (Figure 1).

During the diagnostic work-up, all patients underwent a head CT and/or MRI and CTA. In addition, patients received ECG and routine blood tests, at a minimum. Selected patients also underwent monitoring for paroxysmal atrial fibrillation. TIA diagnoses were made according to World Health Organization (WHO) criteria, in which TIA is defined as a focal neurological deficit caused by central nervous system ischemia and lasting <24 h.¹⁹ Diagnoses were confirmed by a study researcher (TK) and stroke expert (PJ). Patients were excluded if their final diagnostic code after the hospital stay was not TIA.

The data were analyzed using SPSS 27.0 (IBM). An independent samples t-test was used to compare ages between sexes. Incidence rates were calculated for different age groups. Age-standardized incidence rates were calculated using the European standard population 2010. For each incidence rate, we calculated the 95% confidence interval (CI) using the exact method. Analyses were performed using R statistical software (version 4.0.4).

3 | RESULTS

Of 432 patients with a suspected TIA, 139 were excluded from the analysis (56 had transient global amnesia, 29 lived in other hospital districts, and 54 did not have TIA as the final diagnosis in their first hospital admission). In addition to TGA, migraine and stroke were the most common TIA mimics. Figure 1 presents the flowchart of the selected study population.

In Northern Savonia in 2017, 302 TIA attacks were diagnosed and treated in 293 individuals who had TIA or TIA and an ischemic stroke diagnosed during at least one hospital admission. Among all TIA patients, 211 (72%) had a first-ever TIA (105 men and 106 women). Table 2 presents the demographic data of first-ever TIA patients. Among these first-ever TIA cases, 182 (86.3%) underwent head CT, 3 (1.4%) MRI, and 26 head CT along with MRI (12.3%) during hospitalization. In most cases, TIA lasted under 60 min, and this information was missing in 27 patients (12.8%). Among first-ever TIA patients, the symptoms lasted under 10 min in 53 (25.1%), 10–59 min in 84 (39.8%), and over an hour in 47 (22.2%) patients. ABCD₂-scores were 0–3 in 75 (35.5%) first-ever TIA patients, ≥4 in 107 (50.7%),

and missing in 29 (13.7%). The blood pressure measurement in the emergency room was not recorded for two patients.

The age-standardized incidence of first-ever TIA in the Northern Savonia district was 64.0/100,000 in total, 70.8/100,000 among men and 58.1/100,000 among women. The crude overall incidence of TIA was 122/100,000, and 85.5/100,000 for first-ever TIA. Table 3 presents the age- and sex-specific rates of first-ever TIA, along with the 95% CI.

Among first-ever TIA patients, the mean age was 70.2 years, with a significant difference between women (72.0 years) and men (68.4 years; $p < .05$). The first-ever TIA patients over 80 years old were mostly women. Among patients in the 50–54 years and 60–64 years age groups, first-ever TIA was more common in men, in terms of both the number of cases and incidence rates (Table 3). The most common underlying diseases in first-ever TIA patients were hypertensive disease (61%), coronary artery disease (20%), and type 2 diabetes (20%). Prior to TIA, the most commonly used medications included antihypertensive medication (73%), statins (35%), and platelet aggregation inhibitors (27%; Table 2).

4 | DISCUSSION

This is the first-ever report of the incidence of TIA in Finland. The literature includes far fewer reports of TIA incidence than of ischemic stroke incidence. It is possible that the transient nature of the neurological symptoms results in the underestimation of TIA incidence, since people might not always seek medical attention after the resolution of symptoms. Among 98,658 Chinese adults, only 14.6% of TIA patients had sought medical attention, and in the United States, among 10,112 telephone survey participants, 231 had a diagnosed TIA, 44 had had a TIA before the stroke, and 323 people reported having had symptoms typical of TIA but did not have a diagnosis of TIA or stroke made by a physician.^{26,27} According to a Japanese survey, 41.8% of 11,121 respondents aged 20–69 years would visit a family doctor, and 22.4% would call an ambulance, if symptoms of TIA occurred. Almost 30% of survey respondents did not consider TIA as a medical emergency that should be evaluated immediately.²⁸ For only 29% of 12,710 Argentinean people the term TIA was familiar. Yet, 83% of them answered that they would seek medical attention if having transient neurological symptoms.²⁹ In a Danish study, the age-standardized TIA incidence was 62.8/100,000, but 72.2/100,000 when also including 31 patients, who were admitted with ischemic stroke and reported having had a TIA before stroke.¹²

In this hospital-based study, we found that the incidence of first-ever TIA in Northern Savonia, Finland was 64/100,000 when standardized to the European population 2010. The crude overall incidence of first-ever TIA was 86/100,000, and 122/100,000 for all TIA. Since all TIA patients in this specific catchment area are sent to KUH, the results are quite equivalent to a population study. The mean age of the persons with TIA was 70 years, and the men were significantly younger than the women (68 vs. 72 years).

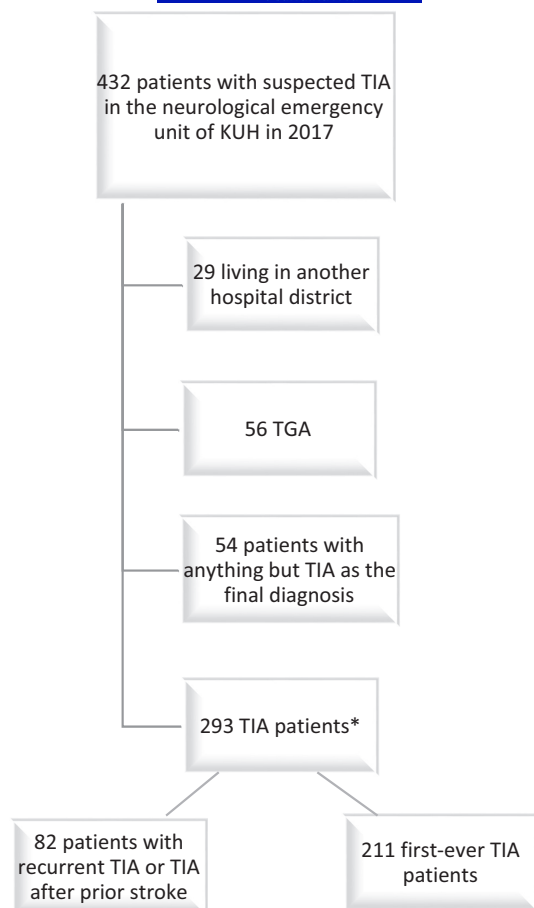


FIGURE 1 Study design. Abbreviations: KUH, Kuopio University Hospital; TIA, transient ischemic attack; TGA, transient global amnesia. *In total, 293 TIA patients had 302 TIA cases

We used the WHO TIA criteria in our study. Despite the new tissue-based TIA criteria published in 2009, most European population-based or hospital-based cohort studies have included TIA diagnosed using WHO criteria,^{9–14,17,30–32} which is the main reason we used the WHO criteria in our study. In the tissue-based TIA criteria (AHA), diagnosis requires a negative MRI scan, with a normal CT scan being the second best option if MRI is not applicable.²¹ According to an international multicenter study, CT has been commonly used in emergency department-based or population-based cohorts, whereas DWI has been used in cohorts from specialist units.²³ The present study population was a hospital-based cohort. In previous reports, DWI has been carried out in 14.3%–100% of TIA patients.^{18,23,33–36} In our hospital, we normally perform CT scanning in TIA patients due to the limited availability of MRI imaging.

Very few published reports have used tissue-based TIA criteria, and no study has compared TIA incidence rates obtained using time-based versus tissue-based criteria using recommended neuroimaging, diffusion-weighted MRI. In a Chinese single-center study, the DWI was used for each time-based TIA patient; however, the report focused on DWI lesions, and TIA incidence was not reported.³⁶ An Italian report showed slight variation in the TIA incidence when time-based TIA criteria (incidence 28.6/100,000) were compared to

TABLE 2 Demographic data of first-ever TIA patients (N = 211)

	First-ever TIA (n = 211)	p value
Age in years, mean ± SD (range)	70.2 ± 12.0 (28–98) M: 68.4 ± 11.9 (37–94) F: 72.0 ± 11.9 (28–98)	<.05
Male	105 (50)	
TIA or stroke in family	20 (9.5)	
Missing	171 (81.0)	
Diagnosed hypertensive disease	128 (60.7)	
Heart diseases		
CAD	43 (20.4)	
AF	29 (13.7)	
Former myocardial infarction	12 (5.7)	
Aortic valve disease	7 (3.3)	
Mitral valve disease	7 (3.3)	
Cardiac insufficiency	3 (1.4)	
Diabetes		
Type 1 diabetes	2 (1.0)	
Type 2 diabetes	43 (20.4)	
Smoking		
Current smokers	30 (14.2)	
Ex-smokers	9 (4.3)	
Medication		
Antihypertensive medication	153 (72.5)	
Statins	73 (34.6)	
Platelet aggregation inhibitors	56 (26.5)	
Warfarin	29 (13.7)	
DOAC	2 (1.0)	

Note: Numbers in parenthesis are percentages, except for age.

Abbreviations: AF, atrial fibrillation; CAD, coronary artery disease; DOAC, direct oral anticoagulants; F, female; M, male.

tissue-based criteria (incidence 20.0/100,000).¹⁸ Many studies of population-based TIA cohorts have lacked MRI availability. In our present study, MRI was carried out for only 29 of 211 TIA patients.

Our present results reveal a rather high incidence of TIA in Northern Savonia in 2017. This might be the consequence of a high level of cardiovascular risk factors in our population. Compared to many other countries, the prevalence of cardiovascular risk factors is among the highest in Finnish and especially in the Eastern Finnish population.³⁷ In 2017, among Finnish people aged over 30 years, 58% of men and 48% of women were hypertensive, 54% of men and 60% of women had hypercholesterolemia, and approximately 15% of men and 10% of women had diabetes. Increased LDL cholesterol was discovered in 52% of men and 53% of women in 2017, and in the Northern Savonia population in 2012 the mean of serum total cholesterol was 5.42 (SD 1.06) in men and 5.25 (SD 0.9) in women.^{38,39}

TABLE 3 Age- and sex-specific incidence rates of first-ever TIA per 100,000 population in Northern Savonia, Finland in 2017

Age group, years	Men				Women				Total			
	N	N at risk	Rate	95% CI	N	N at risk	Rate	95% CI	N	N at risk	Rate	95% CI
0–49	5	68,699	7.28	2.36–17.0	5	65,181	7.67	2.49–17.9	10	133,880	7.47	3.58–13.7
50–54	9	8563	105	48.1–200	3	8243	36.4	7.51–106	12	16,806	71.4	36.9–125
55–59	7	9067	77.2	31.0–159	7	9036	77.5	31.2–160	14	18,103	77.3	42.3–130
60–64	19	9491	200	121–313	8	9428	84.9	36.6–167	27	18,919	143	94.1–208
65–69	17	9338	182	106–291	17	9387	181	106–290	34	18,725	182	126–254
70–74	11	6874	160	79.9–286	22	7587	290	182–439	33	14,461	228	157–320
75–79	18	4603	391	232–618	14	5768	243	133–407	32	10,371	309	211–436
80–84	10	3030	330	158–607	16	4707	340	194–552	26	7737	336	220–492
≥85	9	2364	381	174–723	14	5287	265	145–444	23	7651	301	191–451
All ages	105	122,029	86.0	70.4–104	106	124,624	85.0	69.6–103	211	246,653	85.5	74.4–97.9
ASR			70.8	57.8–86.3			58.1	47.3–71.3			64.0	55.5–73.7

Note: 95% confidence intervals are calculated using the exact method.

Abbreviations: ASR, age-standardized rates (European population 2010); CI, confidence interval.

The mean of body mass index (BMI) in the Northern Savonia population was 27.7 kg/m² (SD 4.8) in men and 26.8 kg/m² (SD 5.7) in women in 2012. In the same year, 26% of men and 14% of women were current smokers in Northern Savonia.³⁹ Among 12 high-income countries (Australia, Canada, Finland, Germany, Ireland, Italy, Japan, New Zealand, South Korea, Spain, the UK, and the USA), in people aged 40–79 years, the prevalence of hypertension was the highest in Finland (52% in women and 59% in men).⁴⁰ In a multinational, prospective cohort study hypertension was reported in 39.4%, and diabetes in 10.2% of people overall in high-income, middle-income, and low-income countries. 20.4% were current smokers, the mean of BMI was 25.7 (SD 5.3), and the mean of serum total cholesterol was 4.9 (SD 4.9).³⁷

Furthermore, the nationwide guidelines of the treatment pathways and systematic education of healthcare professionals as well as the population of Finland focusing on stroke and TIA symptoms and treatment have been going on regularly since intravenous thrombolysis treatment became available. Thus, there is likely a good awareness of TIA symptoms among patients, paramedics, and GPs in Finland, and patients with suspected TIA in our area are always referred to the KUH neurological emergency unit for further examinations. In previous reports, among healthcare professionals, the knowledge of TIA has varied. In a French questionnaire survey for 85 GPs and emergency department physicians, 97.6% of respondents accepted TIA as a medical emergency, and 83.5% considered that hospitalization delay should be <24 h in TIA patients. However, only 41.2% were aware of a new TIA definition.⁴¹ Spanish survey studied the knowledge of TIA among 285 primary care physicians (PCP) and nurses. 83.9% of respondents knew the TIA definition, and 78.2% would have referred a TIA patient to emergency service. However, only 14% recognized all TIA symptoms.⁴² Among 395 German PCPs, 84.8% considered TIA as a medical emergency, but 39% agreed or rather agreed that TIA patients could be diagnosed and treated as outpatients.⁴³

Public stroke educational campaigns may be effective in improving knowledge and awareness. In a review of 13 studies of public stroke education, stroke symptom recognition as well as intention to call emergency medical services were significantly improved in adults aged <65 years.⁴⁴ In Denmark, among 852 strokes and TIA patients, the knowledge of core symptoms of stroke improved both in patients and bystanders, but patient or system delays did not reduce significantly 1 year after the initiation of the Danish stroke campaign.⁴⁵ However, the FAST (Face, Arm, Speech, Time) campaign in the United Kingdom had no impact on response to TIA or minor stroke, whereas in patients with major stroke the delay in seeking medical attention was reduced after the campaign.⁴⁶

The presently determined incidence of TIA was as high as reported in other European countries, with standardized incidence rates of first-ever TIA previously reported to range from 11 to 76 per 100,000 (Table 1).^{9,11–15,18} Outside of Europe, there is wide variation in reported TIA incidence rates, with standardized annual incidence rates varying between 15 and 59 per 100,000, and being lowest in Brazil and highest in Argentina.^{30–32}

The study population in the present study differs in several ways from the study populations in previously reported studies. The catchment area for this study was Northern Savonia, Finland, which had a population of 246,653 in 2017. In the studies presented in Table 1, the catchment areas varied from a specific area (Dijon, France, or L'Aquila, Italy) to a whole country (Sweden), and the population sizes ranged from 18,677 (rural area in Portugal) to 5,996,945–6,298,897 (50–55 hospitals, and 63%–66% of entire population in Sweden).^{9–18,32} The population most similar to ours was in L'Aquila, Italy, which had a total resident population of 298,343 in 2011. The Italian study was also quite similar to ours in terms of the age and sex distributions of the population: females, 51.3% (Italian study) vs. 50.5% (our study); <55 years old, 64.7% vs. 61.1%; >85 years old, 3.6% vs. 3.1%.¹⁸ Our study was a hospital-based, retrospective study. All the previous reports presented in Table 1 are population-based,

and many of them are prospective studies,^{9-15,17,18,30-32} except the Swedish study, which the authors described as “basically a hospital-based study.”¹⁶

While the incidence of stroke has been decreasing over recent decades, previous reports indicate that the incidence rates of TIA attacks have slightly but not significantly increased.⁹⁻¹¹ Recently, in Northern Portugal, the incidence of first-ever TIA increased from 67/100,000 in 1998–2000 to 76/100,000 in 2009–2011.¹⁵ Since the TIA incidence in Finland has never previously been reported, its trend over time is not known. Havulinna et al.⁶ previously reported that the incidence rates of ischemic stroke were significantly higher in Eastern Finland than in Western Finland among both men and women. Northern Savonia is in Eastern Finland. It is unknown whether the geographic variation in IS incidence rates might also be found in TIA incidence rates in Finland.

The risk of TIA increases with age; however, in our study, the incidence rates seemed to decrease among people aged ≥ 85 years. This finding could be explained by the small number of people aged ≥ 85 years, and the same trend has been reported in previous studies.^{12,14} The mean age of first-ever TIA patients was 70.3 years, similar to reports in previous European studies, where the lowest mean age was 66.3 years and the highest 76.4 years.⁹⁻¹⁷ In our study, women had their first-ever TIA at older ages than men (72 vs. 68 years). In a previous study, men were older than women when having a first-ever TIA in rural Northern Portugal, whereas the opposite was found in an urban area.¹⁴ In our study, as in previous studies, the incidence rates were similar between men and women.^{9,12,14} The youngest female patient in our study was 28 years old, and the youngest male patient was 37 years old. The previous study has reported some concerning results showing increasing incidence rates of TIA and stroke in young adults.⁴⁷ However, another recent study did not find this trend.⁴⁸

Among our first-ever TIA patients, the most common risk factors were diagnosed hypertensive disease (>60%), coronary artery disease, and type 2 diabetes (both 20%). In first-ever TIA patients in Northern Portugal, high blood pressure was reported in 65%, hypercholesterolemia in 49%, atrial fibrillation in 9%, coronary heart disease in 15%, and diabetes in 18%.¹⁵ According to a recent multinational registry, metabolic risk factors, especially hypertension, are strongly associated with cardiovascular diseases.³⁷ The decreasing risk of ischemic stroke in Norway is reportedly associated with the decline in systolic blood pressure and decreased prevalence of daily smoking. Increased prevalence of diabetes mellitus has been reported to increase ischemic stroke risk by 4%.⁴⁹ The OXVASC study did not show a decreased TIA incidence; however, among the first-ever TIA patients, blood pressure, mean total cholesterol concentration, and the number of patients who were current smokers significantly declined from 1981–1984 to 2002–2004.⁹

4.1 | Strengths and limitations

The strength of this study is that all patients with suspected TIA in the Northern Savonia catchment area are always referred to KUH for

diagnostics and further examinations to confirm the diagnosis and to detect and treat risk factors for cerebrovascular diseases. In this study, TIA was diagnosed using WHO criteria, to facilitate comparison to previous European reports. All TIA cases were confirmed by study researchers by comparing the referral and final diagnosis. The weakness of our study is that some citizens living in the Northern Savonia area may have had a TIA somewhere else in Finland, and thus the acute phase examinations and diagnosis may have been made at other hospitals. Of the 432 patients with suspected TIA, 29 were living in other hospital districts and were excluded from the analyses. Seven patients had a minor stroke detectable on MRI, but had a TIA based on the WHO criteria and were included in the study population. The WHO criteria may have resulted in an overestimated TIA incidence in this study because not all patients underwent an MRI scan. On the other hand, some patients with transient neurological symptoms may not have sought medical attention, and TIA patients living in permanent nursing homes may not have been referred to a hospital for the examination despite having TIA symptoms. Therefore, the incidence rates of TIA in Eastern Finland are most likely underestimated, or at least not overestimated, in our study.

5 | CONCLUSIONS

The main finding of our study was the high incidence of first-ever TIA in Northern Savonia, Eastern Finland. In the future, it would be interesting to study whether there are geographical differences in first-ever TIA incidence within Finland, as previously shown for ischemic stroke incidence.⁶

AUTHOR CONTRIBUTIONS

All the authors contributed to the planning of the study. TK was responsible for collecting the data from hospital files, and for data analysis. All the authors contributed to the preparation of the manuscript.

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CONFLICT OF INTEREST

The authors have no conflicts of interest to declare.

DATA AVAILABILITY STATEMENT

The data used in this study have been pseudonymized and include personal information, for example age and sex. The EU and national data protection law do not allow publication of these data.

ETHICAL STATEMENT

The study was a retrospective registry study; therefore, informed consent was not required. The data were stored on a secure hospital server. Access to the data required permission from the principal investigator. The data were pseudonymized for the analyses.

Ethics committee permission was waived since in Finland, neither legislation nor guidelines of the Finnish National Board on Research Integrity (TENK) require ethical review by an ethics committee for research based purely on public and published data, registry and documentary data, or archive data.⁵⁰

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