Adrian Kwaśny

Wpływ stanu odżywienia na rokowania pacjentów z chorobami układu sercowo-naczyniowego – różnice płci

The impact of nutritional status on the prognosis of patients with cardiovascular diseases - sex-related differences

Rozprawa doktorska na stopień doktora
w dziedzinie nauk medycznych i nauk o zdrowiu
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Dziękuję Panu Promotorowi dr hab. Michałowi Czapli
za opiekę merytoryczną, wszechstronną pomoc, wsparcie,
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Dziękuję moim Najbliższym,
za niezachwianą wiarę,
wsparcie i cierpliwość.

Spis treści

1. Wykaz publikacji stanowiących rozprawę doktorską

Lp	Opis bibliograficzny	IF	Punkty
1	**Kwaśny A[drian]**, Uchmanowicz I, Juárez-Vela R, Młynarska A, Łokieć K, Czapla M. Sex-related differences in the impact of nutritional status on in- hospital mortality in heart failure: a retrospective cohort study. Eur J Cardiovasc Nurs. 2023 May 25:zvad050. doi: 10.1093/eurjcn/zvad050. Epub	2,9	70
2	**Kwaśny A[drian]**, Łokieć K, Uchmanowicz B, Młynarska A, Smereka J, Czapla M. Sex-related differences in the impact of nutritional status on in-hospital mortality in acute coronary syndrome: a retrospective cohort study. Nutr Metab Cardiovasc Dis. 2023 Jun 19:S0939-4753(23)00243-0. doi: 10.1016/j.numecd.2023.06.010. Epub ahead of print. PMID: 37516641.	3,9	100
3	**Kwaśny A[drian]**, Łokieć K, Uchmanowicz B, Młynarska A, Smereka J, Czapla M. Sex-related differences in the impact of nutritional status on length of hospital stay in atrial fibrillation: a retrospective cohort study. Front Public Health. 2023 Sep 6;11:1223111. doi: 10.3389/fpubh.2023.1223111. PMID: 37744485; PMCID: PMC10516568.	5,2	100
	Podsumowanie	**11,8**	**270**

2. Streszczenie w języku polskim

Wprowadzenie: Stan odżywienia istotnie wpływa na rokowania pacjentów z chorobami układu sercowo-naczyniowego (CVD). Nadwaga i otyłość są poważnymi i powszechnie znanymi czynnikami ryzyka CVD. Zły stan odżywienia jest powiązany z wydłużonym pobytem w szpitalu, zwiększonym ryzykiem ponownej hospitalizacji, zakażeniami szpitalnymi, gorszym gojeniem ran, powikłaniami, a tym samym zwiększonymi kosztami leczenia. Ocena stanu odżywienia może być pomocna w przewidywaniu ryzyka powikłań oraz zgonu. Coraz częściej zwraca się również uwagę na różnice płci w CVD. Płeć jest ważnym wyznacznikiem zdrowia sercowo-naczyniowego i może wpływać na aspekty związane z profilaktyką, czynnikami ryzyka, rozwojem oraz przebiegiem choroby. Zrozumienie mechanizmów związanych z różnicami pomiędzy kobietami a mężczyznami, może pomóc w opracowaniu optymalnych strategii, które związane są zarówno z profilaktyką, jak i właściwym leczeniem.

Cel: Celem badania była ocena wpływu stanu odżywienia ocenionego za pomocą skali Nutritional Risk Score 2002 (NRS-2002) i Body Mass Index (BMI) na śmiertelność wewnątrzszpitalną u pacjentów z niewydolnością serca (HF) i ostrym zawałem mięśnia sercowego (AMI) oraz na długość hospitalizacji (LOHS) u pacjentów z migotaniem przedsionków (AF) w zależności od płci.

Materiał i metody: Do badania włączono 809 pacjentów rozpoznaniem HF, 945 pacjentów z rozpoznaniem AMI oraz 1342 pacjentów z rozpoznaniem AF, którzy spełniali następujące kryteria włączenia: wiek ≥18 lat, odnotowany w dokumentacji przyjęcia wynik BMI oraz NRS-2002. Stan odżywienia pacjentów oceniony został za pomocą wskaźnika BMI oraz skali NRS-2002. Dodatkowo analizie poddane zostały dane kliniczne pacjentów takie jak: wynik BMI, wynik NRS-2002, LOHS oraz choroby

współistniejące. Ryzyko niedożywienia stwierdzano, gdy NRS-2002≥3 pkt. Wynik BMI był interpretowany zgodnie z kryteriami WHO (Światowa Organizacja Zdrowia) tj. niedowaga (BMI<18.5), prawidłowa masa ciała (BMI 18.5–24.9), nadwaga (BMI 25–29.9) otyłość (BMI≥30).

Wyniki: W grupie pacjentów z HF kobiety były istotnie statystycznie starsze od mężczyzn (74,67±11,15 vs. 66,76±17,78; p<0,001). W modelu nieskorygowanym BMI<18,5 (OR=14,81, p=0,001) oraz ryzyko niedożywienia wg NRS-2002 (OR=8,979, p<0,001) były niezależnymi predyktorami śmiertelności wewnątrzszpitalnej wśród mężczyzn. W przypadku kobiet, żadna z tych cech nie była istotna. W modelu skorygowanym o wiek zarówno wynik BMI<18,5 (OR=15,423, p=0,001), jak i ryzyko niedożywienia (OR=5,557, p=0,002) były niezależnymi predyktorami śmiertelności wewnątrzszpitalnej u mężczyzn. W przypadku kobiet nie wykazano takiej zależności. W modelu skorygowanym o wszystkie zmienne w przypadku mężczyzn zarówno BMI<18,5 (OR=15,978, p=0,007), jak i NRS≥3 (OR=4,686, p=0,015) podnosiło szanse zgonu wewnątrzszpitalnego, nie zaś u kobiet.

W grupie pacjentów z AMI kobiety były istotnie starsze od mężczyzn (73,24±11,81 vs 67±11,81). W modelu nieskorygowanym wynik NRS≥3 zwiększał szansę zgonu wewnątrzszpitalnego wśród kobiet. Zależności tej nie odnotowano u mężczyzn. Wieloczynnikowy model regresji logistycznej skorygowany o wszystkie dostępne zmienne wykazał, że ryzyko niedożywienia wg NRS-2002 zwiększało szansę zgonu wewnątrzszpitalnego wśród kobiet (OR=6,555, p=0,007), nie zaś wśród mężczyzn. Nie stwierdzono wpływu wyniku BMI na śmiertelność wewnątrzszpitalną żadnej z płci.

W grupie pacjentów z AF kobiety były istotnie starsze od mężczyzn (72,94±9,56 vs. 65,11±12,68, p<0,001). W przypadku mężczyzn nieskorygowany model regresji liniowej wykazał, że ryzyko niedożywienia wg NRS-2002 było niezależnym

czynnikiem wydłużającym LOHS (B=1,95, p=0,003). Zależności takiej nie odnotowano wśród kobiet. W skorygowanym o wiek modelu regresji liniowej wynik NRS≥3 był istotnym czynnikiem wydłużającym LOHS u mężczyzn (B=1,843, p=0,005), nie zaś u kobiet. W modelu skorygowanym o wiek oraz choroby współistniejące ryzyko niedożywienia nadal pozostawało niezależnym predyktorem wydłużającym LOHS (B=1,285, p=0,043) wśród pacjentów. Zależności tej nie odnotowano wśród pacjentek. W obu grupach nie odnotowano wpływu BMI na LOHS.

Wnioski: W badanej grupie pacjentów z HF, ryzyko niedożywienia oceniane za pomocą skali NRS-2002 oraz niedowaga wg BMI były niezależnymi predyktorami szansy zgonu wewnątrzszpitalnego u mężczyzn. W przypadku kobiet nie wykazano takiej zależności. W grupie pacjentów z AMI, ryzyko niedożywienia ocenione za pomocą skali NRS-2002 było czynnikiem zwiększającym szansę zgonu wewnątrzszpitalnego u kobiet. W przypadku mężczyzn takiej zależności nie wykazano. Nie stwierdzono związku pomiędzy wynikiem BMI a śmiertelnością wewnątrzszpitalną zarówno u kobiet, jak i mężczyzn z AMI. W grupie pacjentów z AF, ryzyko niedożywienia wg NRS-2002 było niezależnym predyktorem długości hospitalizacji u mężczyzn, ale nie u kobiet. W tej grupie nie stwierdzono związku pomiędzy BMI a LOHS zarówno u kobiet, jak i mężczyzn. Wpływ stanu odżywienia na rokowania pacjentów z CVD zależny od płci, różni się w zależności od postawionego rozpoznania.

Słowa kluczowe: stan odżywienia, niedożywienie, otyłość, NRS-2002, wskaźnik masy ciała, niewydolność serca, ostry zespół wieńcowy, migotanie przedsionków, różnice płciowe

3. Streszczenie w języku angielskim (abstract)

Introduction: Nutritional status has a significant impact on the prognosis of patients with cardiovascular disease (CVD). Overweight and obesity are commonly known serious risk factors for CVD. Poor nutritional status is associated with increased length of hospital stay, increased risk of readmission, hospital-acquired infections, worse wound healing, complications and thus increased treatment costs. Assessment of nutritional status can be helpful in predicting the risk of complications and mortality. Attention is increasingly being drawn to sex differences in CVD. Sex is an important determinant of cardiovascular health and can have an impact on aspects relating to the prophylaxis, risk factors, development, and course of CVD. An understanding of mechanisms related to differences between male and female patients can help develop optimum strategies pertaining to both prophylaxis and appropriate treatment.

Aim: The aim of this study was to examine the sex-specific impact of nutritional status, as assessed using the Nutritional Risk Screening 2002 (NRS-2002) and body mass index (BMI), on in-hospital mortality in patients with heart failure (HF) and acute myocardial infarction (AMI) and on length of hospital stay (LOHS) in patients with atrial fibrillation (AF).

Material and methods: The study included 809 patients diagnosed with HF, 945 patients diagnosed with AMI and 1,342 patients diagnosed with AF who met the following inclusion criteria: age ≥18 years, BMI and NRS-2002 scores recorded in the admission record. The nutritional status of the patients was assessed using BMI and the NRS-2002. In addition, the clinical data of the patients, such as BMI, NRS-2002 score, LOHS and comorbidities, were analysed. Patients with an NRS-2002 score of 3 or more were considered at risk of malnutrition. BMI was interpreted according to World Health

Organization (WHO) criteria: underweight (BMI<18.5), normal body weight (BMI 18.5–24.9), overweight (BMI 25–29.9), obesity (BMI ≥30).

Results: Female patients with HF were statistically significantly older than male patients with the condition (74.67±11.15 vs 66.76±17.78; p<0.001). In an unadjusted model, having BMI<18.5 (OR=14.81, p=0.001) and being at risk of malnutrition, as determined by the NRS-2002, (OR=8.979, p<0.001) were independent predictors of in-hospital mortality in male HF patients. Neither of these characteristics was significant in female HF patients. In an age-adjusted model, having BMI<18.5 (OR=15.423, p=0.001) and being at risk of malnutrition (OR=5.557, p=0.002) were independent predictors of in-hospital mortality in male HF patients. No such relationship was found for female HF patients. In a model adjusted for all variables, BMI<18.5 (OR=15.978, p=0.007) and an NRS-2002 score of 3 or more (OR=4.686, p=0.015) increased the odds of in-hospital mortality in male, but not female, HF patients.

Female patients with AMI were significantly older than male AMI patients (73.24±11.81 vs 67±11.81). In an unadjusted model, an NRS-2002 score of 3 or more increased the odds of in-hospital mortality in female AMI patients. No such relationship was found for male AMI patients. In a multivariate model adjusted for all available variables, being at risk of malnutrition, as determined by the NRS-2002, increased the odds of in-hospital mortality in female (OR=6.555, p=0.007), but not male, AMI patients. BMI did not have an impact on in-hospital mortality in either male or female AMI patients.

Female patients with AF were significantly older than male patients with the condition (72.94±9.56 vs. 65.11±12.68, p<0.001). In an unadjusted linear regression model, being at risk of malnutrition, as determined by the NRS-2002, was an independent factor increasing LOHS (B=1.95, p=0.003) in male AF patients. No such relationship was found for female AF patients. In an age-adjusted linear regression model, an NRS-2002 score of 3 or more was a significant factor increasing LOHS in male (B=1.843, p=0.005), but not female, AF patients. In a model adjusted for age and comorbidities, being at risk of malnutrition remained an independent predictor increasing LOHS (B=1.285, p=0.043) in male AF patients. No such relationship was found for female patients with the condition. BMI did not have an impact on LOHS in either male or female AF patients.

Conclusion: In the group of HF patients, the risk of malnutrition according to the NRS-2002 and underweight according to BMI were independent predictors of in-hospital mortality in men. The study did not find such a relationship in women. As for patients with AMI, the risk of malnutrition assessed with NRS-2002 was a factor for increased risk of in-hospital mortality in women. No such relationship was observed in men. The study did not find a relationship between BMI and in-hospital mortality either in female or male patients with AMI. The risk of malnutrition according to the NRS-2002 was an independent predictor of the length of hospital stay in men but not women with AF. In this group of patients, there was no relationship between BMI and LOHS either in women or men. The sex-related impact of nutritional status on the prognosis of CVD patients varies depending on the diagnosis.

Keywords: nutritional status, malnutrition, obesity, NRS-2002, body mass index, heart failure, acute coronary syndrome, atrial fibrillation, sex differences

4. Wykaz stosowanych skrótów

CVD – cardiovascular disease (pl., choroby układu sercowo-naczyniowego)

AF - atrial fibrilation (pl., migotanie przedsionków)

HF – heart failure (pl., niewydolność serca)

AMI - atrial myocardial infarction (pl., ostry zawał mięśnia sercowego)

BMI - atrial myocardial infarction (pl., wskaźnik masy ciała)

HFrEF – heart failure with reduced ejection fraction (pl., niewydolność serca z obniżoną frakcją wyrzutową)

HFpEF – heart failure with preserved ejection fraction (pl., niewydolność serca z zachowaną frakcją wyrzutową)

LOHS – length of hospital stay (pl., długość pobytu w szpitalu)

ICD - International Classification of Diseases (pl. Międzynarodowa Statystyczna Klasyfikacjia Chorób i Problemów Zdrowotnych)

CKD - chronic kidney disease (pl., przewlekła choroba nerek)

HT – hypertension (pl., nadciśnienie tętnicze)

DM – diabetes mellitus (pl., cukrzyca)

TD – thyroid diseases (pl., choroby tarczycy)

CS – cerebral stroke (pl., udar mózgu)

OR - odds ratio (pl., iloraz szans)

5. Wprowadzenie

Choroby układu sercowo-naczyniowego (ang. *cardiovascular diseases*, CVD) stanowią istotny problem zdrowia publicznego i są głównym powodem zgonów na całym świecie [1-2]. Według danych epidemiologicznych, CVD stanowią 49% wszystkich zgonów wśród kobiet i 40% wszystkich zgonów u mężczyzn w Europie [3]. Według danych szacunkowych, migotanie przedsionków (ang. *atrial fibrilation*, AF) dotyka nawet 4% dorosłej populacji [4]. Niewydolność serca (ang. *heart failure*, HF) można nazwać globalną epidemią, gdyż częstość jej występowania przekracza 64 miliony przypadków, a ogólnoświatowe obciążenie ekonomiczne do roku 2030 może wynieść nawet 398,44 miliardów dolarów amerykańskich na całym świecie [5]. Na podstawie oceny specyficznych dla płci i wieku trendów w zakresie śmiertelności z powodu ostrego zawału mięśnia sercowego (ang. *atrial myocardial infarction*, AMI) wykazano, że w latach 2012-2020 doszło do 1 793 314 zgonów (1 048 044 mężczyzn i 745 270 kobiet) z powodu AMI w państwach członkowskich Unii Europejskiej [6].

Stan odżywienia wykazuje istotny wpływ na rokowania pacjentów. Powszechnie uznaje się, że niedożywienie może prowadzić do szeregu konsekwencji klinicznych [7]. Wykazano, że ma ono wpływ m.in. na osłabienie odporności, wydłużenie czasu hospitalizacji, utrudnienie procesu gojenia się ran, zwiększoną częstotliwość powikłań pooperacyjnych, podniesienie ryzyka ponownej hospitalizacji, a w konsekwencji - wzrost kosztów leczenia [8-10]. W badaniu Kootaka i wsp. wykazano, że niedożywienie definiowane według kryteriów GLIM jest czynnikiem predykcyjnym śmiertelności u pacjentów z CVD [11]. Według Raposeiras i wsp. niedożywienie jest powszechne wśród pacjentów z ostrym zespołem wieńcowym i silnie koreluje zarówno ze zwiększoną śmiertelnością, jak i zdarzeniami sercowo-naczyniowymi. Ocena stanu odżywienia może być pomocna w przewidywaniu ryzyka powikłań oraz zgonu [12-13]. Podobnie w przypadku HF, która często łączy się, zarówno z istotną utratą masy beztłuszczowej, jak i z występowaniem kacheksji sercowej [14]. Niedożywienie przebiegające ze wzrostem stężenia cytokin prozapalnych, niedobory żywieniowe, osłabienie siły mięśniowej oraz kacheksja mają wpływ na rokowania u pacjentów z przewlekłą HF [15]. W swojej metaanalizie Lv i wsp. wykazali, że problem niedożywienia może dotyczyć nawet 46% pacjentów z HF i zwiększa ono ryzyko zgonu [16]. Stan odżywienia może również warunkować częstość występowania CVD, w tym m.in. AF. Dodatkowo, wskaźnik masy ciała (ang. *body mass index*, BMI) może być czynnikiem predykcyjnym występowania AF, wiązać się z większą liczbą zdarzeń arytmii oraz mieć wpływ na jej progresję [17-19]. W badaniu Wang i wsp. niedowaga wg BMI<18,5 kg/m^2 u pacjentów z AF była niezależnym czynnikiem ryzyka zgonów ze wszystkich przyczyn [20]. Zależność między stanem odżywienia a ryzykiem AF oraz liczbą jego powikłań może przyjmować kształt litery „U" [21].

Nadwaga i otyłość stanowią ważne czynniki ryzyka CVD [22]. Nadmierna masa ciała przyczynia się bowiem do wystąpienia dyslipidemii, cukrzycy typu 2 czy nadciśnienia tętniczego (HT) [23]. W metaanalizie Asad i wsp. udowodnino, że otyłość wiąże się ze zwiększonym ryzykiem wystąpienia AF, a efekt ten wydaje się być podobny u obu płci [24]. W dostępnej literaturze, zarówno w przypadku HF, jak i AMI oraz AF opisywany jest tzw. „paradoks otyłości" polegający na tym, że u pacjentów z nadwaga i otyłością rokowanie może być lepsze, niżeli w przypadku chorych z prawidłową lub niską masą ciała [25-27]. Problem jednak wydaje się być bardziej złożony i wynikać nie z samej masy ciała, a udziału tkanki tłuszczowej oraz zawartości beztłuszczowej masy ciała [28]. Niedawno opublikowane badania rzucają nowe światło na rozumienie „paradoksu otyłości" wskazując na konieczność różnicowania fenotypów otyłości oraz wpływu innych czynników, takich jak wydolność krążeniowo-oddechowa, stosowane leki, palenie tytoniu czy czas trwania otyłości na rokowania w CVD. [29-30] U chorych z HF sugeruje się, by z dużą ostrożnością podchodzić do definiowania „paradoksu otyłości" na podstawie wyniku BMI [31].

Coraz częściej zwraca się uwagę na istotne różnice między kobietami i mężczyznami w CVD. Płeć jest ważnym wyznacznikiem zdrowia sercowo-naczyniowego, a zrozumienie mechanizmów związanych z różnicami międzypłciowymi wydaje się fundamentalnym krokiem w kierunku opracowywania optymalnych strategii związanych z profilaktyką i leczeniem. Różnice między kobietami i mężczyznami w CVD dotyczyć mogą zarówno profilaktyki, jak czynników ryzyka, ich znaczenia dla rozwoju CVD, patofizjologii oraz sposobu leczenia [32-33]. W przypadku HF płeć może mieć wpływ m.in. na epidemiologię, czynniki ryzyka, patofizjologię, aż po wynik terapii. Mężczyźni częściej cierpią z powodu niewydolności serca z obniżoną frakcją wyrzutową (ang. *heart failure with reduced ejection fraction,* HFrEF), w przypadku kobiet dominuje zaś niewydolność serca z zachowaną frakcją wyrzutową (ang. *heart failure with preserved ejection fraction*, HFpEF) [34]. Z kolei kobiety z AF wykazują znaczące różnice związane z większym ryzykiem wystąpienia objawów i ich nasileniem oraz naturalnym przebiegiem choroby [35]. W badaniu The VITAL Rhythm Study wykazano, że ryzyko wystąpienia AF u kobiet jest mniejsze, jednak po uwzględnieniu różnic związanych ze wzrostem, płeć żeńska była powiązana z wyższym ryzykiem AF [36]. Warto podkreślić, że kobiety są nadal niedostatecznie reprezentowane w badaniach klinicznych, co może prowadzić do niewłaściwego leczenia i opieki [34].

W chwili obecnej istnieje niewiele prac oceniających zależny od płci wpływ stanu odżywienia na rokowania pacjentów z CVD. Podkreślając złożoność problemu, istotnym zatem wydaje się poszukiwanie czynników mających wpływ na śmiertelność wewnątrzszpitalną czy wydłużenie pobytu w szpitalu u pacjentów z CVD.

Ocena czynników mających wpływ na rokowania pacjenta w momencie przyjęcia do szpitala może mieć znaczenie zarówno prognostyczne, jak i ekonomiczne, oraz pozwalać włączyć odpowiednie interwencje we wczesnym etapie leczenia.

6. Cel pracy

Celem pracy była ocena wpływu stanu odżywienia ocenianego za pomocą skali Nutritional Risk Score 2002 (NRS-2002) i BMI na rokowania pacjentów z wybranymi chorobami układu sercowo naczyniowego. Odpowiedzi na powyższe zagadnienie uzyskano poprzez realizację następujących celów szczegółowych, zdefiniowanych w trzech publikacjach włączonych do cyklu badawczego.

Celem pracy oryginalnej pt.: *Sex-related differences in the impact of nutritional status on in- hospital mortality in heart failure: a retrospective cohort study* była ocena wpływu stanu odżywienia ocenionego za pomocą skali NRS-2002 i BMI na śmiertelność wewnątrzszpitalną u pacjentów z HF w zależności od płci.

Celem pracy oryginalnej *Sex-related differences in the impact of nutritional status on in-hospital mortality in acute coronary syndrome: a retrospective cohort study* była ocena wpływu stanu odżywienia ocenionego za pomocą skali NRS-2002 i BMI na śmiertelność wewnątrzszpitalną u chorych z AMI w zależności od płci.

Celem pracy oryginalnej *Sex-related differences in the impact of nutritional status on length of hospital stay in atrial fibrillation: a retrospective cohort study* była ocena wpływu stanu odżywienia ocenionego za pomocą skali NRS-2002 i BMI na długość pobytu w szpitalu (ang. *length of hospital stay*, LOHS) wśród pacjentów z AF w zależności od płci.

7. Materiał i metody

7.1 Charakterystyka badanej grupy

W pracy dokonano retrospektywnej analizy dokumentacji medycznej pacjentów, którzy przyjęci zostali do Instytutu Chorób Serca Uniwersyteckiego Szpitala Klinicznego we Wrocławiu, w okresie od stycznia 2017 roku do czerwca 2021 roku w trybie nagłym z powodu: HF (ICD10: *I50), A*MI *(ICD10: I21)* oraz AF *(ICD10: I48).*

Do badania włączono 809 pacjentów rozpoznaniem HF (publikacja pierwsza), 945 pacjentów z rozpoznaniem AMI (publikacja druga) oraz 1342 pacjentów z rozpoznaniem AF (publikacja trzecia), którzy spełniali następujące kryteria włączenia: wiek≥18 lat, odnotowany w dokumentacji przyjęcia wynik BMI oraz NRS-2002. Analizie poddane zostały dane pacjentów takie jak: wynik BMI, wynik NRS-2002, LOHS oraz choroby współistniejące m.in. takie jak: HF, przewlekła choroba nerek (ang. *chronic kidney disease,* CKD), nadciśnienie tętnicze (ang. *hypertension,* HT), cukrzyca (ang. *diabetes mellitus,* DM), choroby tarczycy (ang. *thyroid disease,* TD), przebyte AMI i udar mózgu (ang. *cerebral stroke,* CS). Badanie zostało przeprowadzone zgodnie z zasadami Deklaracji Helsińskiej i uzyskało zgodę Komisji Bioetycznej przy Uniwersytecie Medycznym we Wrocławiu (protokół nr: KB-837/2022).

7.2 Ocena stanu odżywienia

Stan odżywienia pacjentów oceniony został za pomocą wskaźnika BMI oraz skali NRS-2002. Wskaźnik BMI wyliczono jako stosunek masy ciała do wzrostu podniesionego do kwadratu [kg/m^2]. Wynik BMI interpretowano zgodnie z kryteriami WHO tj. niedowaga (BMI<18.5), prawidłowa masa ciała (BMI 18.5–24.9), nadwaga (BMI 25–29.9), otyłość (BMI≥30) [37]. Ocena ryzyka związanego ze stanem odżywienia przeprowadzona została za pomocą skali NRS-2002. Skala ta składa się z dwóch części.

W pierwszej, dotyczącej pogorszenia stanu odżywienia oceniane są: utrata masy ciała w czasie, wynik BMI oraz występowanie zmniejszonego spożycia pokarmu względem zapotrzebowania energetycznego w ostatnich 7 dniach (0-3 pkt). Część druga ocenia nasilenie ciężkości choroby, które warunkuje zwiększenie zapotrzebowania energetycznego, zgodnie ze skalą: brak – 0 pkt, lekkie – 1 pkt (np. złamanie kości biodrowej, marskość wątroby, cukrzyca), średnie – 2 pkt (np. duże operacje w obrębie jamy brzusznej, udar mózgu, ciężkie zapalenie płuc), ciężkie – 3 pkt (np. uraz głowy, pacjent wymagający intensywnej terapii). Jeśli wiek chorego przekracza 70 lat przyznaje się dodatkowy 1 pkt. Punktacja mieści się w skali od 0 do 7 [38]. U każdego pacjenta z wynikiem ≥3 pkt stwierdzono ryzyko niedożywienia. Wyniki BMI oraz NRS-2002 zostały odnotowane w dokumentacji medycznej pacjenta przez lekarza w chwili przyjęcia do szpitala.

7.3 Analiza statystyczna

Analiza zmiennych ilościowych (tj. wyrażonych liczbą) przeprowadzona została poprzez wyliczenie średniej, odchylenia standardowego, mediany oraz kwartyli. Analizę zmiennych jakościowych (tj. niewyrażonych liczbą) przeprowadzono poprzez wyliczenie liczby i procentu wystąpień każdej z wartości. Porównanie wartości zmiennych jakościowych w grupach uzyskano za pomocą testu chi-kwadrat (z korektą Yatesa dla tabel 2x2) lub dokładnego testu Fishera tam, gdzie w tabelach pojawiły się niskie liczności oczekiwane. Porównanie wartości zmiennych ilościowych w dwóch grupach wykonano za pomocą testu Manna-Whitney'a. Jedno- oraz wieloczynnikową analizę wpływu wielu zmiennych na zmienną dwustanową uzyskano metodą regresji logistycznej. Wyniki przedstawiono w postaci wartości parametrów wyrażonych jako ilorazy szans (ang. *odds ratio*, OR) z 95-procentowym przedziałem ufności.

Jedno- oraz wieloczynnikową analizę wpływu wielu zmiennych na długość hospitalizacji (zmienną ilościową) wykonano metodą regresji liniowej. Wyniki zaprezentowano w postaci wartości parametrów regresji z 95-procentowym przedziałem ufności. Poziom istotności dla wszystkich testów statystycznych przyjęto na poziomie 0,05. Analiza wykonana została w programie R, wersja 4.2.2.

8. Publikacje

8.1 Publikacja nr 1

Adrian Kwaśny, Izabella Uchmanowicz, Raúl Juárez-Vela,

Agnieszka Młynarska, Katarzyna Łokieć, Michał Czapla

"Sex-related differences in the impact of nutritional status on in-hospital mortality in heart failure: a retrospective cohort study"

Adrian Kwaśny, Izabella Uchmanowicz, Raúl Juárez-Vela,
Agnieszka Młynarska, Katarzyna Łokieć, Michał Czapla

Sex-Related Differences in the Impact of Nutritional Status on In-Hospital Mortality in Heart Failure: A Retrospective Cohort Study

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8.2 Publikacja nr 2

Adrian Kwaśny, Katarzyna Łokieć, Bartosz Uchmanowicz,

Agnieszka Młynarska, Jacek Smereka, Michał Czapla

"Sex-related differences in the impact of nutritional status on in-hospital mortality in acute coronary syndrome: A retrospective cohort study"

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Sex-related differences in the impact of nutritional status on in-hospital mortality in acute coronary syndrome: A retrospective cohort study

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Body mass index;
Acute coronary syndrome;
Malnutrition;
Sex differences

Abstract *Background and aims:* In patients with some cardiovascular disease conditions the result of Nutritional Risk Screening 2002 (NRS-2002) and body mass index (BMI) is related to the in-hospital mortality. The aim of this study was to assess the prognostic impact of BMI and NRS 2002 on in-hospital mortality among patients with acute myocardial infarction (AMI) in relation to sex.
Methods and results: The study was based on a retrospective analysis of 945 medical records of AMI patients admitted to the Cardiology Department between 2017 and 2019. Patients with a score NRS2002 $\geq$ 3 are considered to be nutritionally at risk. The WHO BMI criteria were used. The endpoint was in-hospital mortality. Logistic regression was used to analyse the impact of quantitative variables on dichotomous outcome. Odds ratios (OR) with 95% confidence intervals were reported. Female patients were significantly older than male patients (73.24 $\pm$ 11.81 vs 67 $\pm$ 11.81). In an unadjusted model, the risk of malnutrition was a significant predictor of the odds of in-hospital mortality only in female patients (OR = 7.51, p = 0.001). In a multivariate model adjusted by all variables, heart failure (HF) (OR = 8.408, p = 0.003) and the risk of malnutrition (OR = 6.555, p = 0.007) were independent predictors of the odds of in-hospital mortality in female patients. The only significant independent predictor of the odds of in-hospital mortality in male patients was HF (OR = 3.789 p = 0.006).
Conclusions: Only in the case of female patients with AMI, the risk of malnutrition was independently associated with the odds of in-hospital mortality. There was no effect of BMI on in-hospital mortality in both sexes.

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1. Introduction

Cardiovascular disease (CVD) is a serious public health issue as it accounts for almost one-third of all deaths worldwide [1,2]. While the overall incidence and mortality rates of CVD declined in the period from 1990 to 2017, the mortality-to-incidence ratio did not change [3]. Epidemiological studies show that in Europe, CVD accounts for 40% of deaths among men and 49% of deaths among women [4]. According to Jørgensen et al., the elimination of modifiable risk factors, such as unhealthy lifestyle, could prevent 80% of CVD cases [5].

Nutritional status is one of the modifiable factors that have an impact on prognosis in patients with ACS [6]. Malnutrition identified on admission to hospital is an independent risk factor for, among other things, the development of complications, prolonged hospital stay, hospital readmission and all-cause mortality in ACS patients [6–9]. Malnutrition can also affect overweight or obese patients. It is estimated that it may affect up to 50% of ACS patients with obesity [6,10]. As regards obesity, the results of studies vary. While the majority of authors agree that moderate and severe obesity is associated with a higher risk of death from ACS or non-CVD causes, some authors have reported an obesity paradox [11,12], whereby obese patients have better prognosis than their normal weight or underweight counterparts [13]. Nevertheless, assessment of nutritional status can help assess the risk of complications, including death, after ACS [14]. Several nutritional assessment tools have been proposed and extensively used in clinical settings, such as e.g. NRS-2002, Malnutrition Universal Screening Tool (MUST) or Subjective Global Assessment (SGA) [15]. According to the current polish legislation, NRS-2002 or SGA is used to assess nutritional status during hospital admission and it is consistent with the Global Leadership Initiative on Malnutrition guidelines [16]. Also the NRS-2002 is a tool recommended by the European Society of Parenteral and Enteral Nutrition [17,18].

According to Berger et al., women with ACS tend to be older and have more comorbidities (including hyperlipidaemia, diabetes, hypertension and heart failure) compared to male patients with ACS [19]. The results of the Global Use of Strategies to Open Occluded Coronary Arteries in Acute Coronary Syndromes IIb (GUSTO-IIb) study showed that outcomes may differ between men and women with ACS depending on the type of coronary syndrome [20]. Despite differences between men and women in, among other things, anatomy, male and female patients with ACS are treated in the same way based on guidelines developed on the basis of data from RCTs, in which women are under-represented [21]. Guidelines by the European Society of Cardiology note that data from registries and studies show discrepant results with regard to the use of evidence-based therapy, treatment outcomes and access to healthcare between men and women with ACS [22].

The aim of this study was to assess the prognostic impact of NRS-2002 and BMI on in-hospital mortality in patients with AMI in relation to sex.

2. Methods

2.1. Study design and setting

We carried out a retrospective analysis of the medical records of patients admitted with acute myocardial infarction (AMI, ICD10: I21) to the Institute of Heart Diseases (Department of Cardiology) of the University Clinical Hospital in Wrocław (Poland) between January 2017–May 2019.

2.2. Study population and data

We analysed all the patients that met the inclusion criteria. The inclusion criteria were as follows: emergency admission to the Institute of Heart Diseases due to AMI, age $\geq$18 years, BMI and Nutritional Risk Screening 2002 (NRS-2002) score noted in medical records at the time of admission. Exclusion criteria were a diagnosis other than AMI, the lack of a BMI and NRS-2002 result in the patient's medical record. Ultimately, the data of 945 patients, such as BMI, NRS-2002 score, comorbidities, length of hospital stay, were analysed. The primary outcome was in-hospital mortality. Comorbidities and past medical conditions were noted in the patient's medical record by a medical doctor on the admission of the patient to hospital.

2.3. Nutritional screening

Nutritional status was assessed using the NRS-2002 screening tool, which screens for impaired nutritional status (score 0–3, depending on three variables: diet one week before hospitalization, BMI and weight loss) and severity of disease (score 0–3, which classified the patients according to the score of disease-related stress metabolism). An extra point is added to the total score for patients aged $\geq$70. Score ranges on a scale of 0–7. Patients with a score $\geq$3 are considered to be nutritionally at risk [23]. The World Health Organization criteria are used to classify patients as underweight (BMI$<$18.5), normal weight (BMI 18.5–24.9), pre-obese (BMI 25–29.9) and obese (BMI $\geq$ 30) [24]. The NRS-2002 scores and BMI values of the patients were calculated and recorded in the patients' medical records by a medical doctor on the admission of the patients to hospital.

2.4. Ethical considerations

The study was conducted in accordance with the principles of the Declaration of Helsinki and approved by the independent Bioethics Committee of the Wroclaw Medical University (protocol no. KB-837/2022). The study followed the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) guidelines.

2.5. Statistical analysis

Distributions of quantitative variables were described using means, standard deviations, medians and quartiles, whereas distributions of qualitative variables were described with the number and percentage of occurrence for each of their values. The chi-square test (with Yates' correction for 2 × 2 tables) was used to compare qualitative variables among groups. In the case of low values in contingency tables, the Fisher's exact test was used instead. The Mann-Whitney test was used to compare quantitative variables between two groups. Logistic regression was used to analyse the impact of quantitative variables on dichotomous outcome. All clinical variables that were recorded in the medical records at admission to the hospital were used to construct the multivariate model. The final model included the variables of age, sex, type of MI, CKD, HF, CS, HT, DM, Hypercholesterolemia, BMI and NRS-2002. Odds ratios (OR) with 95% confidence intervals were reported. The significance level for all statistical tests was set at 0.05. R 4.2.2. was used for computations.

3. Results

3.1. Comparison of patient characteristics by sex

As shown in Fig. 1, a total of 945 patients were ultimately included in the present study. In a first step, variables were compared by sex. Compared with male patients, female patients were statistically significantly older (73.24 ± 11.81 vs 67 ± 11.81) and were significantly more likely to have such comorbidities as chronic kidney disease (CKD), hypertension (HT) and diabetes mellitus (DM). Female patients were also significantly more likely to be obese. A comparison of patient characteristics by sex is shown in Table 1.

3.2. Comparison of patient characteristics by presence or absence of obesity

Female and male patients were divided into obese (BMI $\geq$ 30) and non-obese (BMI $<$ 30) groups. Female patients with obesity were significantly more likely to have HT and DM compared with non-obese female patients. Male patients with obesity were significantly younger and more likely to have DM and HT compared to non-obese male patients (Table 2).

3.3. Comparison of patient characteristics by risk of malnutrition (as assessed using the NRS-2002 tool)

Female patients at risk of malnutrition were significantly older, were significantly less likely to have HT and DM and had a significantly lower BMI compared to female patients who were not at risk of malnutrition. Moreover, female patients at risk of malnutrition had significantly higher in-hospital mortality.

Male patients at risk of malnutrition were significantly older, had a longer hospital stay and were less likely to have HF and hypercholesterolemia compared to male patients who were not at risk of malnutrition. Moreover, they had a significantly lower BMI compared to male patients not at risk of malnutrition (Table 3).

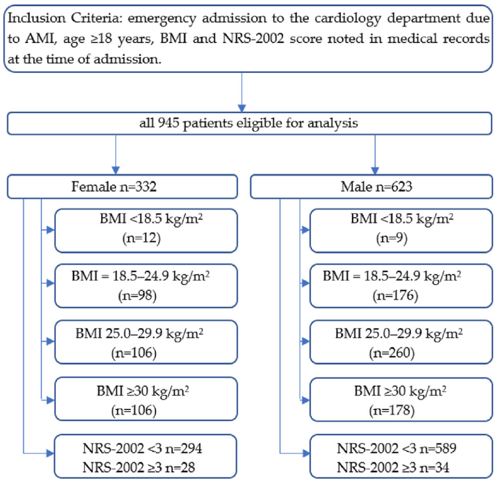

Figure 1 Flow diagram. NRS-2002, Nutritional Risk Screening 2002; BMI, body mass index.

3.4. Impact of BMI and nutritional status (NRS-2002) on mortality − unadjusted

In a multivariate logistic regression model, the risk of malnutrition (NRS-2002 score $\geq$3) was a significant independent predictor of the odds of in-hospital mortality in female ACS patients. Female patients at risk of malnutrition had more than 7-fold higher odds of in-hospital mortality ($OR = 7.51$, $p = 0.001$) compared to female patients not at risk of malnutrition. None of the traits analysed was found to be a significant independent predictor of the odds of in-hospital mortality in male patients (Table 4).

3.5. Impact of BMI and nutritional status (NRS-2002) on mortality - adjusted by the clinical variables listed in Section 3.1

A multivariate logistic regression model showed that HF ($OR = 8.408$, $p = 0.003$) and risk of malnutrition (as determined using the NRS-2002 tool) ($OR = 6.555$, $p = 0.007$) were significant independent predictors of the odds of in-hospital mortality in female ACS patients.

The only significant independent predictor of the odds of in-hospital mortality in male patients was HF ($OR = 3.789$ $p = 0.006$). The impact of BMI and nutritional status (NRS-2002) on mortality in female and male patients is shown in Table 5.

4. Discussion

A number of scientific reports have indicated that there is an association between sex and CVD, including cardiovascular risk, symptom presentation, treatments and prognosis. While previous research has looked at the impact of nutritional status on mortality in patients with

Table 1 Comparison of patient characteristics by sex.

Parameter		Female (N = 322)	Male (N = 623)	Total (N = 945)	p
Age [years]	Mean (SD)	73.24 (11.81)	67 (11.81)	69.13 (12.17)	p < 0.001
	Median (quartiles)	74.5 (66–83)	67 (60–75)	69 (61–78)	
	Range	39–95	32–96	32–96	
	Missing	0	0	0	
LOHS [days]	Mean (SD)	10.62 (6.99)	10.92 (8.06)	10.82 (7.71)	p = 0.307
	Median (quartiles)	8 (6–13)	8 (6–13)	8 (6–13)	
	Range	1–48	1–57	1–57	
	Missing	0	0	0	
Type of MI	STEMI	95 (29.50%)	194 (31.14%)	289 (30.58%)	p = 0.658
	NSTEMI	227 (70.50%)	429 (68.86%)	656 (69.42%)	
CKD	No	226 (70.19%)	509 (81.70%)	735 (77.78%)	p < 0.001
	Yes	96 (29.81%)	114 (18.30%)	210 (22.22%)	
HF	No	234 (72.67%)	457 (73.35%)	691 (73.12%)	p = 0.883
	Yes	88 (27.33%)	166 (26.65%)	254 (26.88%)	
CS	No	289 (89.75%)	572 (91.81%)	861 (91.11%)	p = 0.35
	Yes	33 (10.25%)	51 (8.19%)	84 (8.89%)	
HT	No	46 (14.29%)	163 (26.16%)	209 (22.12%)	p < 0.001[a]
	Yes	276 (85.71%)	460 (73.84%)	736 (77.88%)	
DM	No	176 (54.66%)	407 (65.33%)	583 (61.69%)	p = 0.002[a]
	Yes	146 (45.34%)	216 (34.67%)	362 (38.31%)	
Hypercholesterolemia	No	190 (59.01%)	382 (61.32%)	572 (60.53%)	p = 0.536
	Yes	132 (40.99%)	241 (38.68%)	373 (39.47%)	
BMI	18.5–24.9	98 (30.43%)	176 (28.25%)	274 (28.99%)	p = 0.012[a]
	<18.5	12 (3.73%)	9 (1.44%)	21 (2.22%)	
	25.0–29.9	106 (32.92%)	260 (41.73%)	366 (38.73%)	
	≥30	106 (32.92%)	178 (28.57%)	284 (30.05%)	
NRS-2002	<3	294 (91.30%)	589 (94.54%)	883 (93.44%)	p = 0.077
	≥3	28 (8.70%)	34 (5.46%)	62 (6.56%)	
In-hospital mortality	No	306 (95.03%)	602 (96.63%)	908 (96.08%)	p = 0.306
	Yes	16 (4.97%)	21 (3.37%)	37 (3.92%)	

p – Qualitative variables: chi-square test or Fisher's exact test. Quantitative variables: Mann-Whitney test.
[a] Statistically significant (p < 0.05). Abbreviations: n, number of participants; LOHS, length of hospital stay; HF, heart failure; MI, myocardial infarction; STEMI, ST-elevation myocardial infarction; NSTEMI, non-ST-elevation myocardial infarction; HT, hypertension; DM, diabetes mellitus; CS, cerebral stroke; CKD, chronic kidney disease; NRS-2002, Nutritional Risk Screening 2002.

ACS, little data is available showing differences based on sex and nutritional status. Therefore, in this study we sought to assess the impact of nutritional status on in-hospital mortality in ACS patients in relation to sex. Increased risk of malnutrition is a significant factor affecting, among others, the length of hospital stay, risk of complications, risk of hospital readmission and risk of death in patients with CVD [25–27]. This is also the case for patients with ACS [6]. Poor nutrition, including malnutrition, is also a public health problem for economic reasons [28,29].

Our multivariate logistic regression model showed that female patients with ACS who were at risk of malnutrition had more than 6-fold higher odds of in-hospital mortality (OR = 6.555, p = 0.007). No such relationship was found for male patients. Thus, it seems that the prognostic significance of malnutrition in patients with ACS is of significant clinical interest – especially given that malnutrition among patients with ACS correlates with increased mortality [8,10,30,31]. The result of NutritionDay study shows the prevalence of hospital malnutrition in Europe is 12.9% while in Poland it is 9.4% in the general patient population [32]. Another Polish study documented that a higher risk of in-hospital mortality and readmission to hospital is associated with a NRS-2002 score ≥3, male gender, and a lower than normal body weight [33]. The findings from an observational cohort study in China showed that the risk of malnutrition, as assessed using the Geriatric Nutritional Risk Index (GNRI), is a predictor of adverse prognosis in patients with non-ST elevation ACS [34]. It has also been found that malnutrition, as determined by the GNRI, is an independent factor influencing the development of complications (OR = 2.13, $p < 0.001$) and an important factor influencing in-hospital mortality (OR = 2.48, p < 0,001) in patients with acute MI [7].

Similarly to the present study, Roubin et al. found in their study including patients with ACS that malnutrition was more common in female patients [31]. According to Takahashi et al., malnutrition is associated with unfavourable outcomes in patients with ACS. In that study, nutritional status was assessed using the Controlling Nutritional Status (CONUT) score [35]. It should be noted that women have less muscle mass than men. Moreover, while women are more susceptible to disuse muscle atrophy, they have a smaller loss of muscle mass with ageing, which may be associated with the difference in muscle mass between the sexes [36,37]. It seems that there is a relationship between muscle mass and mortality, especially in women [38,39]. While this hypothesis should be treated with caution, anthropometric differences

Table 2 Comparison of patient characteristics by presence or absence of obesity.

Parameter		Female (N = 322)		p	Male (N = 623)		P
		Obese (N = 106)	Non-obese (N = 216)		Obese (N = 178)	Non-obese (N = 445)	
Age [years]	Mean (SD)	71.99 (10.59)	73.86 (12.34)	0.076	65.21 (11.53)	67.72 (11.86)	0.021[a]
	Median (quartiles)	72 (65.25–79)	76 (66–84)		66 (59–71)	68 (60–76)	
	Range	42–95	39–94		34–92	32–96	
	Missing	0	0		0	0	
LOHS [days]	Mean (SD)	10.43 (7.84)	10.71 (6.54)	0.197	11.36 (9.25)	10.74 (7.54)	0.868
	Median (quartiles)	8 (6.25–11)	9 (6–13)		8 (6–13)	8 (6–13)	
	Range	1–48	1–45		2–57	1–44	
	Missing	0	0		0	0	
Type of MI	STEMI	28 (26.42%)	67 (31.02)	0.471	45 (25.28)	149 (33.48%)	0.057
	NSTEMI	78 (73.58%)	149 (68.98)		133 (74.72)	296 (66.52%)	
CKD	No	74 (69.81%)	152 (70.37)	1	148 (83.15)	361 (81.12%)	0.635
	Yes	32 (30.19%)	64 (29.63)		30 (16.85)	84 (18.88%)	
HF	No	71 (66.98%)	163 (75.46)	0.141	126 (70.79)	331 (74.38%)	0.414
	Yes	35 (33.02%)	53 (24.54)		52 (29.21)	114 (25.62%)	
CS	No	99 (93.40%)	190 (87.96)	0.188	166 (93.26)	406 (91.24%)	0.503
	Yes	7 (6.60%)	26 (12.04)		12 (6.74%)	39 (8.76%)	
HT	No	6 (5.66%)	40 (18.52)	0.003[a]	32 (17.98)	131 (29.44%)	0.005[a]
	Yes	100 (94.34%)	176 (81.48)		146 (82.02)	314 (70.56%)	
DM	No	39 (36.79%)	137 (63.43)	<0.001[a]	92 (51.69)	315 (70.79%)	<0.001[a]
	Yes	67 (63.21%)	79 (36.57)		86 (48.31%)	130 (29.21%)	
Hypercholesterolemia	No	65 (61.32%)	125 (57.87)	0.638	105 (58.99)	277 (62.25%)	0.507
	Yes	41 (38.68%)	91 (42.13)		73 (41.01)	168 (37.75%)	
NRS-2002	<3	101 (95.28%)	193 (89.35)	0.118	169 (94.94)	420 (94.38%)	0.933
	≥3	5 (4.72%)	23 (10.65)		9 (5.06%)	25 (5.62%)	
In-hospital mortality	No	102 (96.23%)	204 (94.44)	0.675	175 (98.31)	427 (95.96%)	0.219
	Yes	4 (3.77%)	12 (5.56%)		3 (1.69%)	18 (4.04%)	

p – Qualitative variables: chi-square test or Fisher's exact test. Quantitative variables: Mann-Whitney test.
[a] Statistically significant ($p < 0.05$). Abbreviations: n, number of participants; LOHS, length of hospital stay; HF, heart failure; MI, myocardial infarction; STEMI, ST-elevation myocardial infarction; NSTEMI, non-ST-elevation myocardial infarction; HT, hypertension; DM, diabetes mellitus; CS, cerebral stroke; CKD, chronic kidney disease; NRS-2002, Nutritional Risk Screening 2002.

between men and women may have an influence on prognosis. A number of studies have noted differences between male and female patients with ACS in terms of other aspects such as epidemiology, care, symptom presentation and treatment outcomes [40,41]. A limited number of studies evaluating gender-specific predictors of malnutrition in the adult population are available. However, it is worth noting the important influence of sexual dimorphism in body weight and composition, hormonal distinctiveness, and different rates of muscle and bone mass loss in malnutrition [36,42]. A dataset from The Irish Longitudinal Study of Ageing isolated gender-dependent predictors of malnutrition identifying cognitive impairment or receipt of social support as determinants of malnutrition in women [43]. Sexual biological difference in the rate of aging, decrease in muscle and bone mass and deterioration of mental performance may indirectly explain the higher risk of mortality among women due to complications of malnutrition.

In one study based on data from the Improving Care for Cardiovascular Disease in China-Acute Coronary Syndrome project, the in-hospital mortality rate was higher in female patients with ACS compared to male ACS patients (2.60% vs 1.50%, $P < 0.001$) [44]. In the present study, the in-hospital mortality rate was also higher in female patients (4.97% vs 3.37%). However, the finding was not statistically significant. In their study, Dawson et al. examined differences in epidemiology, care and outcomes between male and female patients attended by EMS for acute undifferentiated chest pain. The study found that women diagnosed with ST-segment elevation myocardial infarction had a higher thirty-day and long-term mortality [41]. Female patients with ACS are usually older and have more comorbidities compared with their male counterparts [45]. Attention should also be given to the obesity paradox, which is discussed in numerous publications. Our study did not show protective effects of obesity. However, a meta-analysis by Şaylık et al. on the effect of the obesity paradox on mortality in patients with ACS found a U-shaped nonlinear association between BMI and mortality risk – patients with BMI <21.5 kg/m2 and >40 kg/m2 had a higher risk of death [46]. Some authors have noted sex differences in the obesity paradox in patients with ACS. In a study by Migaj et al., the obesity paradox was only observed in male ACS patients [47]. In a study by Keller et al., women with ACS had higher in-hospital mortality compared to male ACS patients; however, sex differences were attenuated by obesity, with the obesity paradox and the protective effects of obesity observed in female patients [48].

It is difficult to assess nutritional status and risk of malnutrition in patients with ACS on their admission to

Table 3 Comparison of patient characteristics by risk of malnutrition (NRS-2002).

Parameter		Female (N = 322)			Male (N = 623)		
		NRS ≥ 3 n = 28 (8.69%)	NRS < 3 n = 294 (91,31%)	P	NRS ≥ 3 n = 34 (5.46%)	NRS < 3 n = 589 (94.54%)	P
Age [years]	Mean (SD)	82.29 (7.84)	72.38 (11.77)	0.001[a]	74.88 (11.86)	66.55 (11.66)	0.001[a]
	Median (quartiles)	83.5 (76.75–88.25)	73 (65–82)		75.5 (66–84.5)	67 (60–74)	
	Range	65–93	39–95		46–93	32–96	
	Missing	0	0		0	0	
LOHS [days]	Mean (SD)	10 (9.38)	10.68 (6.73)	0.23	16.88 (11.07)	10.58 (7.73)	0.001[a]
	Median (quartiles)	8.5 (5–10.25)	8 (6–13)		14.5 (7.5–23.75)	8 (6–12)	
	Range	2–48	1–45		2–39	1–57	
	Missing	0	0		0	0	
Type of MI	STEMI	8 (28.57%)	87 (29.59%)	1	5 (14.71%)	189 (32.09%)	0.053
	NSTEMI	20 (71.43%)	207 (70.41%)		29 (85.29%)	400 (67.91%)	
CKD	No	17 (60.71%)	209 (71.09%)	0.352	23 (67.65%)	486 (82.51%)	0.051
	Yes	11 (39.29%)	85 (28.91%)		11 (32.35%)	103 (17.49%)	
HF	No	19 (67.86%)	215 (73.13%)	0.707	16 (47.06%)	441 (74.87%)	0.001[a]
	Yes	9 (32.14%)	79 (26.87%)		18 (52.94%)	148 (25.13%)	
CS	No	25 (89.29%)	264 (89.80%)	1	29 (85.29%)	543 (92.19%)	0.186
	Yes	3 (10.71%)	30 (10.20%)		5 (14.71%)	46 (7.81%)	
HT	No	8 (28.57%)	38 (12.93%)	0.042[a]	11 (32.35%)	152 (25.81%)	0.52
	Yes	20 (71.43%)	256 (87.07%)		23 (67.65%)	437 (74.19%)	
DM	No	22 (78.57%)	154 (52.38%)	0.014[a]	20 (58.82%)	387 (65.70%)	0.526
	Yes	6 (21.43%)	140 (47.62%)		14 (41.18%)	202 (34.30%)	
Hypercholesterolemia	No	20 (71.43%)	170 (57.82%)	0.231	28 (82.35%)	354 (60.10%)	0.016[a]
	Yes	8 (28.57%)	124 (42.18%)		6 (17.65%)	235 (39.90%)	
BMI	<18.5	3 (10.71%)	9 (3.06%)	0.027[a]	4 (11.76%)	5 (0.85%)	0.001[a]
	18.5–24.9	13 (46.43%)	85 (28.91%)		12 (35.29%)	164 (27.84%)	
	25.0–29.9	7 (25.00%)	99 (33.67%)		9 (26.47%)	251 (42.61%)	
	≥30	5 (17.86%)	101 (34.35%)		9 (26.47%)	169 (28.69%)	
In-hospital mortality	No	22 (78.57%)	284 (96.60%)	0.001[a]	31 (91.18%)	571 (96.94%)	0.101
	Yes	6 (21.43%)	10 (3.40%)		3 (8.82%)	18 (3.06%)	

p - Qualitative variables: chi-square test or Fisher's exact test. Quantitative variables: Mann-Whitney test.
[a] Statistically significant ($p < 0.05$). Abbreviations: n, number of participants; LOHS, length of hospital stay; HF, heart failure; MI, myocardial infarction; STEMI, ST-elevation myocardial infarction; NSTEMI, non-ST-elevation myocardial infarction; HT, hypertension; DM, diabetes mellitus; CS, cerebral stroke; CKD, chronic kidney disease; NRS-2002, Nutritional Risk Screening 2002.

hospital due to the dynamic nature and complexity of life-saving interventions. However, screening in this regard is necessary. Our study did not find a relationship between BMI and the risk of in-hospital mortality. However, ACS patients with low body weight have a higher incidence of adverse cardiovascular events, may not be treated optimally, and their comorbidities may increase their risk of death [49]. Moreover, it should be noted that awareness of malnutrition and its impact on treatment and prognosis is low [6]. Our findings imply that further prospective research is needed on factors related to sex differences and nutritional status and their impact on mortality in patients with ACS.

Table 4 Impact of BMI and nutritional status (NRS-2002) on mortality in male and female patients with ACS (unadjusted).

Female	Trait		OR	95% CI		p
	BMI	18.5–24.9	1	Ref.		
		<18.5	–	–	–	–
		25.0–29.9	0.344	0.087	1.359	0.128
		≥30	0.509	0.144	1.793	0.293
	NRS-2002	<3	1	ref.		
		≥3	7.51	2.395	23.554	0.001 *
Male	**Trait**		**OR**	**95% CI**		**p**
	BMI	18.5–24.9	1	Ref.		
		<18.5	1.394	0.141	13.786	0.777
		25.0–29.9	0.479	0.178	1.29	0.145
		≥30	0.29	0.078	1.075	0.064
	NRS-2002	<3	1	ref.		
		≥3	2.505	0.645	9.732	0.185

p – Multivariate logistic regression, * statistically significant ($p < 0.05$) Abbreviations: n, number of participants; BMI, Body Mass Index; NRS-2002, Nutritional Risk Screening 2002.

4.1. Clinical implications

Nutrition treatment education and implementation should be an integral part of the therapeutic process. Monitoring the nutritional status of patients during hospitalization, extensive malnutrition prevention activities and the selection of appropriate interventions for malnourished patients should be part of the therapeutic process. Starting nutritional treatment in malnourished patients as soon as possible can affect prognosis, show prognostic and economic significance. Indeed, the impact of malnutrition on mortality, length of hospital stay, and intensity of treatment has been demonstrated. Undoubtedly, these elements can increase the cost of treatment [28,50,51].

Table 5 Impact of BMI and nutritional status (NRS-2002) on mortality — female patients (adjusted model).

Female	Trait		OR	95% CI		p
	Age	[years]	1.051	0.988	1.118	0.117
	Type of MI	STEMI	1	Ref.		
		NSTEMI	0.91	0.249	mar.33	0.886
	CKD	No	1	Ref.		
		Yes	0.235	0.042	1.324	0.101
	HF	No	1	Ref.		
		Yes	8.408	02.lut	35.003	0.003 *
	CS	No	1	Ref.		
		Yes	2.663	0.589	12.049	0.203
	HT	No	1	Ref.		
		Yes	0.268	0.052	1.367	0.113
	DM	No	1	Ref.		
		Yes	0.318	0.069	1.464	0.141
	Hypercholesterolemia	No	1	Ref.		
		Yes	0.364	0.086	1.539	0.169
	BMI	18.5−24.9	1	Ref.		
		<18.5	–	–	–	–
		25.0−29.9	0.384	0.084	1.756	0.217
		≥30	0.912	0.21	3.955	0.902
	NRS-2002	<3	1	Ref.		
		≥3	6.555	1.653	25.989	0.007 *
Male	**Trait**		**OR**	**95% CI**		**p**
	Age	[years]	1.046	0.998	1.097	0.06
	Type of MI	STEMI	1	Ref.		
		NSTEMI	0.51	0.18	1.447	0.206
	CKD	No	1	Ref.		
		Yes	1.197	0.41	3.494	0.742
	HF	No	1	Ref.		
		Yes	3.785	1.456	9.838	0.006 *
	CS	No	1	Ref.		
		Yes	0.811	0.17	3.867	0.793
	HT	No	1	Ref.		
		Yes	0.513	0.186	1.414	0.197
	DM	No	1	Ref.		
		Yes	1.366	0.512	3.641	0.534
	Hypercholesterolemia	No	1	Ref.		
		Yes	0.228	0.05	1.054	0.058
	BMI	18.5−24.9	1	Ref.		
		<18.5	2.7	0.235	30.984	0.425
		25.0−29.9	0.629	0.214	1.851	0.4
		≥30	0.395	0.097	1.603	0.194
	NRS-2002	<3	1	Ref.		
		≥3	1.014	0.236	4.361	0.985

p − Multivariate logistic regression * statistically significant ($p < 0.05$); Abbreviations: HF, heart failure; MI, myocardial infarction; STEMI, ST-elevation myocardial infarction; NSTEMI, non-ST-elevation myocardial infarction; HT, hypertension; DM, diabetes mellitus; CS, cerebral stroke; CKD, chronic kidney disease; NRS-2002, Nutritional Risk Screening 2002.

4.2. Study limitations

One limitation of our study is that it included a small number of patients at risk of malnutrition. Those patients accounted for 6.56% of the study population. Also, in-hospital mortality was found to be only 6 women in the risk of malnutrition group. Moreover, as the study was retrospective in nature, it did not include assessment of the body composition of the patients using bioelectrical impedance or measurement of the waist-to-hip ratio. Moreover, data on central obesity based on waist circumference were not recorded. The medical records were also lacking information on the previous treatment of patients (e.g., with lipid-lowering drugs). We also had no information on what treatment of AMI was and this may also have an impact on in-hospital mortality in this group of patients. This is a retrospective study and gathered data from past admissions by medical doctors to hospital. Not all patients undergo testing for biochemical markers of malnutrition on admission, thus we cannot comment on these indicators and their effect on nutritional status in this study. Due to the restrictions of access to the personal data of patients arising from Polish law, we were not able to assess the long-term survival of the ACS patients included in the study.

5. Conclusions

The risk of malnutrition according to the NRS-2002 results were a factor which increased the odds of in-hospital mortality in female patients admitted to the cardiology department due to AMI, but not in their male counterparts. The study did not find a relationship between BMI and in-hospital mortality in female and male patients with AMI. However, due to the small number of participants that were at risk of malnutrition, these results should be interpreted within the context of each patient. Undoubtedly, the impact of BMI and NRS-2002 results in patients hospitalized in the cardiology department due to AMI relative to sex requires further investigation.

Author contributions

Conceptualization: A.K. and M.C; methodology: A.K. and M.C; software: A.K. and K.Ł.; validation: M.C. and A.K.; formal analysis: A.K and M.C..; investigation: M.C., B.U, A.M., K.Ł., J.S..; resources: A.K. and M.C.; data curation: A.K.; writing-original draft preparation: A.K. and M.C.; writing-review and editing: A.K., M.C.; visualization: A.K., A.M.; supervision: M.C.; project administration: K.Ł.; funding acquisition: J.S. All authors have read and agreed to the published version of the manuscript.

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Data availability statement

The data are available by contacting the corresponding author.

Declaration of competing interest

The authors declare no conflict of interest.

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References

[1] Mensah GA, Roth GA, Fuster V. The global burden of cardiovascular diseases and risk factors: 2020 and beyond. J Am Coll Cardiol 2019; 74(20):2529–32. https://doi.org/10.1016/j.jacc.2019.10.009.

[2] GBD 2016 Causes of Death Collaborators. Global, regional, and national age-sex specific mortality for 264 causes of death, 1980-2016: a systematic analysis for the Global Burden of Disease Study 2016. Lancet Lond Engl 2017;390(10100):1151–210. https://doi.org/10.1016/S0140-6736(17)32152-9.

[3] Amini M, Zayeri F, Salehi M. Trend analysis of cardiovascular disease mortality, incidence, and mortality-to-incidence ratio: results from global burden of disease study 2017. BMC Publ Health 2021;21(1): 401. https://doi.org/10.1186/s12889-021-10429-0.

[4] Townsend N, Wilson L, Bhatnagar P, Wickramasinghe K, Rayner M, Nichols M. Cardiovascular disease in Europe: epidemiological update 2016. Eur Heart J 2016;37(42):3232–45. https://doi.org/10.1093/eurheartj/ehw334.

[5] Jørgensen T, Jacobsen RK, Toft U, Aadahl M, Glümer C, Pisinger C. Effect of screening and lifestyle counselling on incidence of ischaemic heart disease in general population: inter 99 randomised trial. BMJ 2014;348:g3617. https://doi.org/10.1136/bmj.g3617.

[6] Kang SH, Song HN, Moon JY, et al. Prevalence and prognostic significance of malnutrition in patients with acute coronary syndrome treated with percutaneous coronary intervention. Medicine 2022; 101(34):e30100. https://doi.org/10.1097/MD.0000000000030100.

[7] Yoo SH, Kook HY, Hong YJ, Kim JH, Ahn Y, Jeong MH. Influence of undernutrition at admission on clinical outcomes in patients with acute myocardial infarction. J Cardiol 2017;69(3):555–60. https://doi.org/10.1016/j.jjcc.2016.05.009.

[8] Ando T, Yoshihisa A, Kimishima Y, et al. Prognostic impacts of nutritional status on long-term outcome in patients with acute myocardial infarction. Eur J Prev Cardiol 2020;27(19):2229–31. https://doi.org/10.1177/2047487319883723.

[9] Deutz NE, Matheson EM, Matarese LE, et al. Readmission and mortality in malnourished, older, hospitalized adults treated with a specialized oral nutritional supplement: a randomized clinical trial. Clin Nutr Edinb Scotl 2016;35(1):18–26. https://doi.org/10.1016/j.clnu.2015.12.010.

[10] Tonet E, Campo G, Maietti E, et al. Nutritional status and all-cause mortality in older adults with acute coronary syndrome. Clin Nutr Edinb Scotl 2020;39(5):1572–9. https://doi.org/10.1016/j.clnu.2019.06.025.

[11] Williams MJA, Lee M, Alfadhel M, Kerr AJ. Obesity and all cause mortality following acute coronary syndrome (ANZACS-QI 53). Heart Lung Circ 2021;30(12):1854–62. https://doi.org/10.1016/j.hlc.2021.04.014.

[12] Niedziela J, Hudzik B, Niedziela N, et al. The obesity paradox in acute coronary syndrome: a meta-analysis. Eur J Epidemiol 2014; 29(11):801–12. https://doi.org/10.1007/s10654-014-9961-9.

[13] Carbone S, Canada JM, Billingsley HE, Siddiqui MS, Elagizi A, Lavie CJ. Obesity paradox in cardiovascular disease: where do we stand? Vasc Health Risk Manag 2019;15:89–100. https://doi.org/10.2147/VHRM.S168946.

[14] Balayah Z, Alsheikh-Ali AA, Rashed W, et al. Association of obesity indices with in-hospital and 1-year mortality following acute coronary syndrome. Int J Obes 2021;45(2):358–68. https://doi.org/10.1038/s41366-020-00679-0.

[15] Domenech-Briz V, Gea-Caballero V, Czapla M, et al. Importance of nutritional assessment tools in the critically ill patient: a systematic review. Front Nutr 2023:9. Accessed May 10, 2023, https://www.frontiersin.org/articles/10.3389/fnut.2022.1073782.

[16] Cederholm T, Jensen GL, Correia MITD, et al. GLIM criteria for the diagnosis of malnutrition - a consensus report from the global clinical nutrition community. Clin Nutr Edinb Scotl 2019;38(1): 1–9. https://doi.org/10.1016/j.clnu.2018.08.002.

[17] Cederholm T, Barazzoni R, Austin P, et al. ESPEN guidelines on definitions and terminology of clinical nutrition. Clin Nutr Edinb Scotl 2017;36(1):49–64. https://doi.org/10.1016/j.clnu.2016.09.004.

[18] Singer P, Blaser AR, Berger MM, et al. ESPEN guideline on clinical nutrition in the intensive care unit. Clin Nutr 2019;38(1):48–79. https://doi.org/10.1016/j.clnu.2018.08.037.

[19] Berger JS, Elliott L, Gallup D, et al. Sex differences in mortality following acute coronary syndromes. JAMA, J Am Med Assoc 2009; 302(8):874–82. https://doi.org/10.1001/jama.2009.1227.

[20] Hochman JS, Tamis JE, Thompson TD, et al. Sex, clinical presentation, and outcome in patients with acute coronary syndromes. Global use of Strategies to open occluded coronary Arteries in acute coronary syndromes IIb investigators. N Engl J Med 1999; 341(4):226–32. https://doi.org/10.1056/NEJM199907223410402.

[21] Haider A, Bengs S, Luu J, et al. Sex and gender in cardiovascular medicine: presentation and outcomes of acute coronary syndrome. Eur Heart J 2020;41(13):1328–36. https://doi.org/10.1093/eurheartj/ehz898.

[22] Collet JP, Thiele H, Barbato E, et al. 2020 ESC Guidelines for the management of acute coronary syndromes in patients presenting

without persistent ST-segment elevation. Eur Heart J 2021;42(14): 1289–367. https://doi.org/10.1093/eurheartj/ehaa575.

[23] Kondrup J, Allison SP, Elia M, Vellas B, Plauth M. Educational and clinical practice committee, European society of parenteral and enteral nutrition (ESPEN). ESPEN guidelines for nutrition screening 2002. Clin Nutr Edinb Scotl 2003;22(4):415–21. https://doi.org/10.1016/s0261-5614(03)00098-0.

[24] WHO Consultation on Obesity (1999: Geneva S, Organization WH). Obesity : preventing and managing the global epidemic : report of a WHO consultation. World Health Organization; 2000. Accessed December 31, 2022, https://apps.who.int/iris/handle/10665/42330.

[25] Czapla M, Uchmanowicz I, Juárez-Vela R, et al. Relationship between nutritional status and length of hospital stay among patients with atrial fibrillation – a result of the nutritional status heart study. Front Nutr 2022;9:1086715. https://doi.org/10.3389/fnut.2022.1086715.

[26] Czapla M, Juárez-Vela R, Łokieć K, Wleklik M, Karniej P, Smereka J. The association between nutritional status and length of hospital stay among patients with hypertension. Int J Environ Res Publ Health 2022;19(10):5827. https://doi.org/10.3390/ijerph19105827.

[27] Chen W, Shi S, Tu J, et al. Nutrition-related diseases and cardiovascular mortality in American society: national health and nutrition examination study, 1999–2006. BMC Publ Health 2022; 22(1):1849. https://doi.org/10.1186/s12889-022-14257-8.

[28] Correia MITD, Waitzberg DL. The impact of malnutrition on morbidity, mortality, length of hospital stay and costs evaluated through a multivariate model analysis. Clin Nutr Edinb Scotl 2003; 22(3):235–9. https://doi.org/10.1016/s0261-5614(02)00215-7.

[29] Boban M, Bulj N, Kolačević Zeljković M, et al. Nutritional considerations of cardiovascular diseases and treatments. Nutr Metab Insights 2019;12:1178638819833705. https://doi.org/10.1177/1178638819833705.

[30] Basta G, Chatzianagnostou K, Paradossi U, et al. The prognostic impact of objective nutritional indices in elderly patients with ST-elevation myocardial infarction undergoing primary coronary intervention. Int J Cardiol 2016;221:987–92. https://doi.org/10.1016/j.ijcard.2016.07.039.

[31] Raposeiras Roubín S, Abu Assi E, Cespón Fernandez M, et al. Prevalence and prognostic significance of malnutrition in patients with acute coronary syndrome. J Am Coll Cardiol 2020;76(7): 828–40. https://doi.org/10.1016/j.jacc.2020.06.058.

[32] Ostrowska J, Sulz I, Tarantino S, Hiesmayr M, Szostak-Węgierek D. Hospital malnutrition, nutritional risk factors, and elements of nutritional care in Europe: comparison of polish results with all European countries participating in the nDay survey. Nutrients 2021;13(1):263. https://doi.org/10.3390/nu13010263.

[33] Budzyński J, Tojek K, Czerniak B, Banaszkiewicz Z. Scores of nutritional risk and parameters of nutritional status assessment as predictors of in-hospital mortality and readmissions in the general hospital population. Clin Nutr 2016;35(6):1464–71. https://doi.org/10.1016/j.clnu.2016.03.025.

[34] Q Z, Ty Z, Yj C, et al. Impacts of geriatric nutritional risk index on prognosis of patients with non-ST-segment elevation acute coronary syndrome: results from an observational cohort study in China. Nutr Metab Cardiovasc Dis NMCD 2020;30(10). https://doi.org/10.1016/j.numecd.2020.05.016.

[35] Takahashi T, Watanabe T, Otaki Y, et al. Prognostic significance of the controlling nutritional (CONUT) score in patients with acute coronary syndrome. Heart Ves 2021;36(8):1109–16. https://doi.org/10.1007/s00380-021-01792-4.

[36] Della Peruta C, Lozanoska-Ochser B, Renzini A, et al. Sex differences in inflammation and muscle wasting in aging and disease. Int J Mol Sci 2023;24(5):4651. https://doi.org/10.3390/ijms24054651.

[37] Gallagher D, Ruts E, Visser M, et al. Weight stability masks sarcopenia in elderly men and women. Am J Physiol Endocrinol Metab 2000;279(2):E366–75. https://doi.org/10.1152/ajpendo.2000.279.2.E366.

[38] Srikanthan P, Horwich TB, Tseng CH. Relation of muscle mass and fat mass to cardiovascular disease mortality. Am J Cardiol 2016; 117(8):1355–60. https://doi.org/10.1016/j.amjcard.2016.01.033.

[39] Kouvari M, Chrysohoou C, Dilaveris P, et al. Skeletal muscle mass in acute coronary syndrome prognosis: gender-based analysis from Hellenic Heart Failure cohort. Nutr Metab Cardiovasc Dis NMCD 2019;29(7):718–27. https://doi.org/10.1016/j.numecd.2019.03.011.

[40] van Oosterhout REM, de Boer AR, Maas AHEM, Rutten FH, Bots ML, Peters SAE. Sex differences in symptom presentation in acute coronary syndromes: a systematic review and meta-analysis. J Am Heart Assoc Cardiovasc Cerebrovasc Dis 2020;9(9):e014733. https://doi.org/10.1161/JAHA.119.014733.

[41] Dawson LP, Nehme E, Nehme Z, et al. Sex differences in epidemiology, care, and outcomes in patients with acute chest pain. J Am Coll Cardiol 2023;81(10):933–45. https://doi.org/10.1016/j.jacc.2022.12.025.

[42] Schilp J, Wijnhoven HAH, Deeg DJH, Visser M. Early determinants for the development of undernutrition in an older general population: Longitudinal Aging Study Amsterdam. Br J Nutr 2011; 106(5):708–17. https://doi.org/10.1017/S0007114511000717.

[43] Corish CA, Bardon LA. Malnutrition in older adults: screening and determinants. Proc Nutr Soc 2019;78(3):372–9. https://doi.org/10.1017/S0029665118002628.

[44] Hao Y, Liu J, Liu J, et al. Sex differences in in-hospital management and outcomes of patients with acute coronary syndrome. Circulation 2019;139(15):1776–85. https://doi.org/10.1161/CIRCULATIONAHA.118.037655.

[45] Blomkalns AL, Chen AY, Hochman JS, et al. Gender disparities in the diagnosis and treatment of non-ST-segment elevation acute coronary syndromes: large-scale observations from the CRUSADE (can rapid risk stratification of unstable angina patients suppress adverse outcomes with early implementation of the American college of cardiology/American heart association guidelines) national quality improvement initiative. J Am Coll Cardiol 2005; 45(6):832–7. https://doi.org/10.1016/j.jacc.2004.11.055.

[46] Şaylık F, Çınar T, Hayıroğlu Mİ. Effect of the obesity paradox on mortality in patients with acute coronary syndrome: a comprehensive meta-analysis of the literature. Balkan Med J 2023;40(2): 93–103. https://doi.org/10.4274/balkanmedj.galenos.2022.2022-11-56.

[47] Migaj J, Prokop E, Straburzyńska-Migaj E, Lesiak M, Grajek S, Mitkowski P. Does the influence of obesity on prognosis differ in men and women? A study of obesity paradox in patients with acute coronary syndrome. Kardiologia Pol Pol Heart J 2015;73(9): 761–7. https://doi.org/10.5603/KP.a2015.0087.

[48] Keller K, Münzel T, Ostad MA. Sex-specific differences in mortality and the obesity paradox of patients with myocardial infarction ages >70 y. Nutrition 2018;46:124–30. https://doi.org/10.1016/j.nut.2017.09.004.

[49] Rivera-Caravaca JM, Ruiz-Nodar JM, Tello-Montoliu A, et al. Low body weight and clinical outcomes in acute coronary syndrome patients: results of the ACHILLES registry. Eur J Cardiovasc Nurs 2017;16(8):696–703. https://doi.org/10.1177/1474515117710155.

[50] Norman K, Pichard C, Lochs H, Pirlich M. Prognostic impact of disease-related malnutrition. Clin Nutr 2008;27(1):5–15. https://doi.org/10.1016/j.clnu.2007.10.007.

[51] Lim SL, Ong KCB, Chan YH, Loke WC, Ferguson M, Daniels L. Malnutrition and its impact on cost of hospitalization, length of stay, readmission and 3-year mortality. Clin Nutr Edinb Scotl 2012; 31(3):345–50. https://doi.org/10.1016/j.clnu.2011.11.001.

8.3 Publikacja nr 3

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Sex-related differences in the impact of nutritional status on length of hospital stay in atrial fibrillation: a retrospective cohort study

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Background: Nutritional status is related to the length of hospitalization of patients with atrial fibrillation (AF). The aim of this study is to assess the prognostic impact of nutritional status and body mass index on length of hospital stay (LOHS) among patients with AF relative to their sex.

Methods: A retrospective analysis of the medical records of 1,342 patients admitted urgently with a diagnosis of AF (ICD10: I48) to the Cardiology Department (University Hospital in Wroclaw, Poland) between January 2017 and June 2021.

Results: In the study group, women were significantly older than men (72.94 ± 9.56 vs. 65.11 ± 12.68, $p < 0.001$). In an unadjusted linear regression model, malnutrition risk was a significant independent predictor of prolonged hospitalization in men (B = 1.95, $p = 0.003$) but not in women. In the age-adjusted linear regression model, malnutrition risk was a significant independent predictor of prolonged hospitalization in men (B = 1.843, $p = 0.005$) but not in women. In the model adjusted for age and comorbidities, malnutrition risk was a significant independent predictor of prolonged hospitalization in men only (B = 1.285, $p = 0.043$). In none of the models was BMI score a predictor of LOHS in either sex.

Conclusion: The risk of malnutrition directly predicts the length of hospital stays in men but not women. The study did not find a relationship between body mass index and length of hospital stay in both women and men.

KEYWORDS

nutritional status, obesity, malnutrition, sex difference, body mass index, atrial fibrillation

1. Introduction

Atrial fibrillation (AF) is estimated to affect about 2–4% of the adult population, and the incidence is projected to continue to increase up to 4-fold by 2050 (1–3). Both malnutrition and overweight and obesity are challenges to modern public health in developed and developing countries (4). Excess body weight is associated with high cardiovascular risk, risk of prolonged hospitalization and mortality (5–7). Despite knowledge on the subject, malnutrition remains one of the most common causes of death in developing countries. In 70% of cases, nutritional deterioration occurs during hospitalization (8, 9). Several publications indicate an association between AF incidence and overweight and obesity. Studies show a relationship between AF risk and body weight; overweight and underweight were associated with higher arrhythmia events during the follow-up period. It was confirmed that body mass index (BMI), waist circumference, hip circumference and body surface area, among others, were independent predictors of atrial fibrillation (10–12). Thacker et al. observed that higher BMI was an independent factor in arrhythmia progression from paroxysmal or persistent AF to fixed AF, in contrast to other factors (13). Also, a higher BMI score is an independent factor in the progression of arrhythmias from paroxysmal to sustained atrial fibrillation, in contrast to other cardiovascular risk factors (14). Pathak et al. showed that a 10% weight loss in obese patients resulted in a sixfold greater likelihood of maintaining sinus rhythm than patients with no change in body weight values (15). Although some researchers have described a phenomenon occurring among AF patients called the "obesity paradox" concerning deaths from all causes and those from cardiovascular causes, there is an inverse relationship between overweight/obesity and better cardiovascular prognosis at long-term follow-up (16, 17). There are studies showing gender differences in AF (18, 19). However, data on the relationship between nutritional status, gender and length of hospitalization in AF are scarce. This thread has not been sufficiently explored, justifying the need for such observations.

The aim of this study is to assess the prognostic impact of NRS-2002 and body mass index on length of hospital stay (LOHS) among patients with AF relative to their sex.

2. Materials and methods

2.1. Study design and setting

A retrospective analysis of the medical records of 1,342 patients admitted urgently with a diagnosis of AF (ICD10: I48) to the Cardiology Department (Institute of Heart Diseases, University Hospital in Wroclaw, Poland) between January 2017 and June 2021 was conducted.

2.2. Study population and data

Medical records of all patients who met the following inclusion criteria were included in the analysis: emergency admission to the cardiology department for AF (primary reason for hospital admission), BMI and Nutritional Risk Screening 2002 (NRS-2002) score noted in medical records at the time of admission, age ≥18 years old. Finally, data from 1,342 patients were analyzed, such as NRS-2002 score, Body Mass Index (BMI) score, comorbidities: heart failure (HF), chronic kidney disease (CKD), arterial hypertension (HT), diabetes mellitus (DM), thyroid disease (TD), history of cerebral stroke; acute coronary syndrome (ACS) and length of hospital stay (LOHS). Comorbidities and past medical conditions have been recorded by a doctor in the patient's medical record when the patient is admitted to the hospital.

2.3. Tools for assessing nutritional status

Risk of malnutrition was assessed using the screening tools NRS-2002 (20). This tool assesses impaired nutritional status (0–3 points) and severity of disease (0–3 points). If the patient's age ≥70 years, the patient receives 1 point more. The risk of malnutrition was found when the patient received ≥3 points (20). The WHO criteria for indicating nutritional status are used to classify patients as obese (BMI ≥ 30), pre-obese (BMI 25–29.9), normal body weight (BMI 18.5–24.9), and underweight (BMI < 18.5) (21). Both the NRS-2002 and the BMI score were assessed and recorded in the patient's medical record by the physician at the time of admission to the hospital.

2.4. Ethical considerations

The study was conducted following the principles of the Declaration of Helsinki and approved by the independent Bioethics Committee of Wroclaw Medical University, protocol no. KB-837/2022. The study followed the STROBE guidelines (Strengthening the Reporting of Observational Studies in Epidemiology).

2.5. Statistical analysis

Distributions of quantitative variables were summarized with mean, standard deviation, median and quartiles. In contrast, distributions of qualitative variables were summarized with the number and percent of occurrence for each value. Chi-squared test (with Yates' correction for 2×2 tables) was used to compare qualitative variables among groups. In the case of low values in contingency tables, Fisher's exact test was used instead. Mann–Whitney test was used to compare quantitative variables between two groups. Logistic regression was used to analyze the impact of quantitative variables on dichotomous outcomes. All clinical variables recorded in medical records at hospital admission were used to construct a multivariate model. Odds ratios (OR) with 95% confidence intervals were shown. The significance level for all statistical tests was set to 0.05. R 4.2.2. was used for computations.

3. Results

3.1. Comparison of patient characteristics by sex

All 1,342 patients were included in the analysis. In the first step, a comparison was made concerning gender. A comparison of the groups by gender is shown in Table 1. Women were significantly older than men (72.94 ± 9.56 vs. 65.11 ± 12.68, $p < 0.001$). Women were also significantly more likely than men to suffer from CKD, thyroid disease

TABLE 1 Comparison of patient characteristics by sex.

Parameter		Female (*N* = 568)	Male (*N* = 774)	Total (*N* = 1,342)	*p*
Age [years]	Mean (SD)	72.94 (9.56)	65.11 (12.98)	68.42 (12.28)	<0.001*
	Median (quartiles)	72 (68–80)	67 (59–73)	70 (63–76)	
	Range	31–94	19–95	19–95	
Type of AF	Paroxysmal	236 (41.55%)	281 (36.30%)	517 (38.52%)	0.04*
	Persistent	227 (39.96%)	363 (46.90%)	590 (43.96%)	
	Permanent	105 (18.49%)	130 (16.80%)	235 (17.51%)	
HF	No	449 (79.05%)	639 (82.56%)	1,088 (81.07%)	0.121
	Yes	119 (20.95%)	135 (17.44%)	254 (18.93%)	
DM	No	449 (79.05%)	613 (79.20%)	1,062 (79.14%)	1
	Yes	119 (20.95%)	161 (20.80%)	280 (20.86%)	
CKD	No	474 (83.45%)	688 (88.89%)	1,162 (86.59%)	0.005*
	Yes	94 (16.55%)	86 (11.11%)	180 (13.41%)	
CS	No	491 (86.44%)	697 (90.05%)	1,188 (88.52%)	0.05*
	Yes	77 (13.56%)	77 (9.95%)	154 (11.48%)	
HT	No	233 (41.02%)	346 (44.70%)	579 (43.14%)	0.197
	Yes	335 (58.98%)	428 (55.30%)	763 (56.86%)	
ACS	No	502 (88.38%)	699 (90.31%)	1,201 (89.49%)	0.294
	Yes	66 (11.62%)	75 (9.69%)	141 (10.51%)	
TD	No	411 (72.36%)	682 (88.11%)	1,093 (81.45%)	<0.001*
	Yes	157 (27.64%)	92 (11.89%)	249 (18.55%)	
BMI	18.5–24.9	154 (27.11%)	182 (23.51%)	336 (25.04%)	0.124
	<18.5	2 (0.35%)	3 (0.39%)	5 (0.37%)	
	25.0–29.9	193 (33.98%)	310 (40.05%)	503 (37.48%)	
	≥30	219 (38.56%)	279 (36.05%)	498 (37.11%)	
NRS-2002	<3	460 (80.99%)	652 (84.24%)	1,112 (82.86%)	<0.001*
	≥3	63 (11.09%)	30 (3.88%)	93 (6.93%)	
	Unknown	45 (7.92%)	92 (11.89%)	137 (10.21%)	
LOHS [days]	Mean (SD)	4.41 (3.16)	4.31 (3.42)	4.35 (3.31)	0.234
	Median (quartiles)	4 (3–6)	3 (2–5)	3 (2–5.75)	
	Range	1–26	1–34	1–34	
BMI [kg/m²]	Mean (SD)	28.95 (5.55)	28.67 (4.58)	28.79 (5.01)	0.654
	Median (quartiles)	28.3 (24.6–32.8)	28.1 (25.2–31.6)	28.3 (25–32)	
	Range	18.5–48.9	18.5–56.8	18.5–56.8	

p – qualitative variables: chi-squared or Fisher's exact test. Quantitative variables: Mann–Whitney test. *Statistically significant ($p < 0.05$). *n*, number of participants; AF, atrial fibrillation; HF, heart failure; CKD, chronic kidney disease; HT, arterial hypertension; DM, diabetes mellitus; CS, cerebral stroke; ACS, acute coronary syndrome; TD, thyroid disease; BMI, body mass index; NRS-2002, Nutritional Risk Score; LOHS, length of hospital stay.

and stroke history. This group also had a higher risk of malnutrition (11.09% vs. 3.99%, $p < 0.001$).

3.2. Group comparison relative to obesity

Patients of each gender were divided into two groups according to WHO criteria: obese (BMI ≥ 30) and non-obese (BMI < 30). Women with obesity were significantly more likely to be younger and have DM compared to women in the non-obese group. Women with obesity were significantly less likely to have CKD, CS and less likely to have malnutrition risk, according to NRS-2002, compared to the obese group. Obese men were significantly younger than non-obese men. Obese men were less often at risk in malnutrition (Table 2).

3.3. Group comparison against malnutrition risk

Women at risk for malnutrition were significantly older. They also were more likely to have CKD and less likely to have HT and TD, and had a lower BMI compared to the group without malnutrition risk.

TABLE 2 Comparison of patient characteristics by absence or presence of obesity.

Parameter		Female (*N* = 568)			Male (*N* = 794)		
		Obese (*N* = 219)	Non-obese (*N* = 349)	*p*	Obese (*N* = 279)	Non-obese (*N* = 495)	*p*
Age [years]	Mean (SD)	70.13 (7.24)	74.7 (10.38)	<0.001*	63.78 (10.39)	65.85 (14.19)	0.001*
	Median (quartiles)	70 (66.5–74)	74 (68–83)		66 (58–70)	68 (60–74)	
	Range	46–91	31–94		35–93	19–95	
Type of AF	Paroxysmal	79 (36.07%)	157 (44.99%)	<0.001*	77 (27.60%)	204 (41.21%)	<0.001*
	Persistent	113 (51.60%)	114 (32.66%)		163 (58.42%)	200 (40.40%)	
	Permanent	27 (12.33%)	78 (22.35%)		39 (13.98%)	91 (18.38%)	
HF	No	167 (76.26%)	282 (80.80%)	0.234	220 (78.85%)	419 (84.65%)	0.052
	Yes	52 (23.74%)	67 (19.20%)		59 (21.15%)	76 (15.35%)	
DM	No	160 (73.06%)	289 (82.81%)	0.008*	213 (76.34%)	400 (80.81%)	0.169
	Yes	59 (26.94%)	60 (17.19%)		66 (23.66%)	95 (19.19%)	
CKD	No	193 (88.13%)	281 (80.52%)	0.024*	248 (88.89%)	440 (88.89%)	1
	Yes	26 (11.87%)	68 (19.48%)		31 (11.11%)	55 (11.11%)	
CS	No	200 (91.32%)	291 (83.38%)	0.01*	254 (91.04%)	443 (89.49%)	0.573
	Yes	19 (8.68%)	58 (16.62%)		25 (8.96%)	52 (10.51%)	
HT	No	79 (36.07%)	154 (44.13%)	0.07	117 (41.94%)	229 (46.26%)	0.277
	Yes	140 (63.93%)	195 (55.87%)		162 (58.06%)	266 (53.74%)	
ACS	No	197 (89.95%)	305 (87.39%)	0.428	250 (89.61%)	449 (90.71%)	0.711
	Yes	22 (10.05%)	44 (12.61%)		29 (10.39%)	46 (9.29%)	
TD	No	165 (75.34%)	246 (70.49%)	0.245	248 (88.89%)	434 (87.68%)	0.701
	Yes	54 (24.66%)	103 (29.51%)		31 (11.11%)	61 (12.32%)	
NRS-2002	<3	187 (85.39%)	273 (78.22%)	<0.001*	236 (84.59%)	416 (84.04%)	0.006*
	≥3	4 (1.83%)	59 (16.91%)		3 (1.08%)	27 (5.45%)	
LOHS [days]	Mean (SD)	4.25 (2.98)	4.52 (3.27)	0.527	4.13 (2.87)	4.41 (3.7)	0.953
	Median (quartiles)	4 (2.5–6)	4 (3–6)		3 (2–5)	3 (2–5)	
	Range	1–24	1–26		1–22	1–34	

p – qualitative variables: chi-squared or Fisher's exact test. Quantitative variables: Mann–Whitney test. *Statistically significant ($p < 0.05$). *n*, number of participants; AF, atrial fibrillation; HF, heart failure; CKD, chronic kidney disease; HT, arterial hypertension; DM, diabetes mellitus; CS, cerebral stroke; ACS, acute coronary syndrome; TD, thyroid disease; TG, triglycerides; LDL, low-density lipoprotein; HDL, high-density lipoprotein; TC, total cholesterol; hsCRP, high-sensitivity C-reactive protein; K, potassium; Na, sodium; BMI, body mass index; NRS-2002, Nutritional Risk Score; LOHS, length of hospital stay.

Men at risk of malnutrition were less likely to have diseases such as DM and HT. Men in this group also lower BMIs than men at no malnutrition risk (Table 3).

3.4. Effect of BMI and NRS-2002 on LOHS – unadjusted and adjusted for age

For women, a multivariate linear regression model showed that none of the analyzed characteristics was a significant independent predictor of hospitalization length. However, for men, a significant independent predictor of prolonged hospitalization was the risk of malnutrition (B = 1.95; $p = 0.003$), which prolonged hospitalization by an average of almost 1.95 days (Table 4). In an age-adjusted linear regression model, this proved to be a significant independent predictor of LOHS in both women (B = 0.072, $p < 0.001$) and men (B = 0.035, $p = 0.001$). In addition, in men, the risk of malnutrition remained a significant independent predictor (B = 1.843, $p = 0.005$), which on average prolonged hospitalization by 1.843 days (Table 4).

3.5. Impact of BMI and NRS on length of hospitalization – adjusted for comorbidities

For female patients, a multivariate linear regression model showed that significant independent predictors of length of hospitalization are age (B = 0.075), persistent AF (B = 0.717), and HT (B = −0.751). In male patients, independent predictors of length of hospitalization are age (B = 0.029), persistent AF (B = −0.612), permanent AF (B = 1.217), history of stroke (B = −1.598), and HT (B = −0.979). Still, despite the addition of comorbidities to the model, the risk of malnutrition was a significant independent factor affecting the length of hospitalization (B = 1.285, $p = 0.043$) in men (Table 5).

TABLE 3 Group comparison concerning malnutrition risk.

Parameter		Female (N = 523)			Male (N = 682)		
		NRS ≥ 3 (N = 63)	NRS < 3 (N = 460)	p	NRS ≥ 3 (N = 30)	NRS < 3 (N = 652)	p
Age [years]	Mean (SD)	76.59 (10.78)	72.65 (9.52)	<0.001*	69.77 (17.39)	65.18 (12.89)	0.051
	Median (quartiles)	78 (72–84)	72 (67–80)		72.5 (64–83)	67 (59–73)	
	Range	31–92	33–94		26–95	19–95	
Type of AF	Paroxysmal	26 (41.27%)	194 (42.17%)	0.985	9 (30.00%)	240 (36.81%)	0.197
	Persistent	24 (38.10%)	175 (38.04%)		12 (40.00%)	300 (46.01%)	
	Permanent	13 (20.63%)	91 (19.78%)		9 (30.00%)	112 (17.18%)	
HF	No	50 (79.37%)	363 (78.91%)	1	26 (86.67%)	538 (82.52%)	0.733
	Yes	13 (20.63%)	97 (21.09%)		4 (13.33%)	114 (17.48%)	
DM	No	51 (80.95%)	369 (80.22%)	1	29 (96.67%)	514 (78.83%)	0.032*
	Yes	12 (19.05%)	91 (19.78%)		1 (3.33%)	138 (21.17%)	
CKD	No	43 (68.25%)	390 (84.78%)	0.002*	24 (80.00%)	577 (88.50%)	0.154
	Yes	20 (31.75%)	70 (15.22%)		6 (20.00%)	75 (11.50%)	
CS	No	53 (84.13%)	396 (86.09%)	0.821	27 (90.00%)	585 (89.72%)	1
	Yes	10 (15.87%)	64 (13.91%)		3 (10.00%)	67 (10.28%)	
HT	No	35 (55.56%)	184 (40.00%)	0.027*	23 (76.67%)	281 (43.10%)	0.001*
	Yes	28 (44.44%)	276 (60.00%)		7 (23.33%)	371 (56.90%)	
ACS	No	53 (84.13%)	408 (88.70%)	0.399	30 (100.00%)	582 (89.26%)	0.062
	Yes	10 (15.87%)	52 (11.30%)		0 (0.00%)	70 (10.74%)	
TD	No	53 (84.13%)	323 (70.22%)	0.031*	27 (90.00%)	571 (87.58%)	1
	Yes	10 (15.87%)	137 (29.78%)		3 (10.00%)	81 (12.42%)	
BMI	Underweight	2 (3.17%)	0 (0.00%)	<0.001*	0 (0.00%)	3 (0.46%)	<0.001*
	Normal	36 (57.14%)	116 (25.22%)		19 (63.33%)	152 (23.31%)	
	Overweight	21 (33.33%)	157 (34.13%)		8 (26.67%)	261 (40.03%)	
	Obesity	4 (6.35%)	187 (40.65%)		3 (10.00%)	236 (36.20%)	
LOHS [days]	Mean (SD)	4.48 (2.84)	4.5 (3.22)	0.802	6.4 (5.85)	4.33 (3.27)	0.051
	Median (quartiles)	4 (2–6.5)	4 (3–6)		4 (3–7)	3 (3–5)	
	Range	1–13	1–26		1–23	1–34	

p – qualitative variables: chi-squared or Fisher's exact test. Quantitative variables: Mann–Whitney test. *Statistically significant (p < 0.05). n, number of participants; AF, atrial fibrillation; HF, heart failure; CKD, chronic kidney disease; HT, arterial hypertension; DM, diabetes mellitus; CS, cerebral stroke; ACS, acute coronary syndrome; TD, thyroid disease; BMI, body mass index; NRS-2002, Nutritional Risk Score; LOHS, length of hospital stay.

4. Discussion

The impact of nutritional status on CVD is widely reported in the scientific literature. Its effects can range from the risk of cardiovascular events, presentation of symptoms, condition treatment methods, length of hospitalization and influence patient prognosis. The association of obesity with AF and the effect of weight reduction on its course is well known (22). It is also known that being underweight can be an independent risk factor for AF, and the association of BMI with AF risk takes a "U" shape (23). Scientific reports are also increasingly pointing out the gender differences present in atrial fibrillation (24). However, to the best of our knowledge, this study is one of the few to evaluate gender differences in the effect of nutritional status on the length of hospitalization in patients with AF, highlighting the complexity of this problem.

In the study, a multivariate linear regression model showed that malnutrition risk, as determined by the NRS-2002 scale, was a significant independent predictor of prolonged LOHS in men (B = 1.285, p = 0.005). No such effect was demonstrated in women. We also noted no effect of BMI score on LOHS for either sex. A study by Cheng et al. confirmed the impact of malnutrition on clinical outcomes, which showed that moderate to severe malnutrition is an independent predictor of adverse prognosis among older adult patients with non-valvular AF (25). The impact on LOHS was also evaluated in the work of Alturi et al., where it was shown that protein-calorie malnutrition in patients with AF could prolong hospital stay by 2.76 days (26). When comparing the groups in relation to the risk of malnutrition, statistically significant differences in the length of hospitalization in both men and women were not registered. However, the length of hospitalization is prolonged in the group of men with NRS ≥ 3 (6.4 vs. 4.33), which, although not statistically significant, may be clinically relevant and affect the total cost of treatment.

TABLE 4 Effect of BMI and NRS-2002 on LOHS – unadjusted and adjusted for age.

Unadjusted model	Trait		B	95%CI		p
Female	BMI	18.5–24.9	ref.			
		<18.5	−1.976	−6.467	2.515	0.389
		25.0–29.9	0.203	−0.494	0.9	0.569
		≥30	−0.072	−0.776	0.632	0.841
	NRS-2002	<3	ref.			
		≥3	0.012	−0.871	0.894	0.98
Male	BMI	18.5–24.9	ref.			
		<18.5	−1.561	−5.468	2.346	0.434
		25.0–29.9	−0.318	−0.982	0.346	0.348
		≥30	−0.263	−0.947	0.42	0.45
	NRS-2002	<3	ref.			
		≥3	1.95	0.674	3.226	0.003*
Adjusted for age	**Trait**		**B**	**95%CI**		**p**
Female	BMI	18.5–24.9	ref.			
		<18.5	−0.59	−5.017	3.837	0.794
		25.0–29.9	0.167	−0.515	0.849	0.632
		≥30	0.228	−0.471	0.927	0.523
	NRS-2002	<3	ref.			
		≥3	−0.213	−1.081	0.656	0.631
	Age	[years]	0.072	0.043	0.1	<0.001*
Male	BMI	18.5–24.9	ref.			
		<18.5	−1.842	−5.722	2.037	0.352
		25.0–29.9	−0.218	−0.879	0.443	0.518
		≥30	−0.115	−0.798	0.568	0.742
	NRS-2002	<3	ref.			
		≥3	1.843	0.576	03.lis	0.005*
	Age	[years]	0.035	0.015	0.054	0.001*

B, unstandardized regression coefficient; *p*, multiple linear regression. *Statistically significant ($p < 0.05$). BMI, Body Mass Index; NRS-2002, Nutrition Risk Screening.

The risk of malnutrition can be studied using several different tools. Zhu et al. evaluated the effect of malnutrition assessed by the nutritional status score (CONUT score) and geriatric nutritional risk index (GNRI) on AF recurrence in patients after ablation procedures. They found that malnourished patients were more likely to experience AF recurrence (27). Malnutrition can also affect the increased risk of complications. Kim et al. showed that it increases the risk of complications in AF patients undergoing catheter ablation. The overall complication rate was more marked among malnourished women (7.1%) than malnourished men (3.7%) (28). Monitoring patients' nutritional status is essential to the medical care process, as it can deteriorate during a hospital stay (29). The assessment should be performed at the time of admission to the hospital and during hospitalization. This is because it has been shown that a drop in category on the Subjective Global Assessment (SGA) or significant weight loss during the first week of hospitalization may be associated with a greater likelihood of a longer hospital stay (30).

In our study, only males had malnutrition risk according to NRS-2002 as a significant independent predictor of LOHS. Although this hypothesis requires further research, it may be influenced by different body fat content relative to gender. It is indicated that with similar BMI, the body fat percentage in men is lower than in women (31). In our study, we also found no effect of BMI on LOHS in either sex, which seems to confirm the lack of reflection of body composition in the BMI parameter. This is because it does not consider body fat, muscle mass or water content but only the patient's weight-to-height ratio.

Researchers identify multiple determinants of prolonged hospital stay for patients with AF. Independent predictors of LOHS include acute coronary syndromes, acute decompensated heart failure, heart failure with reduced ejection fraction, and elevated NT-proBNP levels (32). Sex differences in AF are related to comorbidities, the influence of sex hormones, differences in electrophysiology, endothelial dysfunction, and pro-inflammatory signalling, among other factors (33). Researchers indicate that women with AF have a larger left atrial diameter, which affects their mortality (34), prolonged hospitalization time compared to men after ablation (35), and a higher risk of AF recurrence after radiofrequency catheter ablation (35). Women with AF also report poorer overall quality of life (36). Although in our

TABLE 5 Effect of BMI and NRS-2002 on LOHS in men and women – adjusted model.

	Trait		B	95%CI		p
Female	Age	[years]	0.075	0.045	0.105	<0.001*
	Type of AF	Paroxysmal	ref.			
		Persistent	0.717	0.119	1.315	0.019*
		Permanent	0.028	−0.753	0.808	0.945
	HF	No	ref.			
		Yes	0.434	−0.286	1.153	0.238
	DM	No	ref.			
		Yes	−0.043	−0.756	0.67	0.905
	CKD	No	ref.			
		Yes	−0.474	−1.266	0.317	0.241
	CS	No	ref.			
		Yes	−0.379	−1.213	0.456	0.374
	HT	No	ref.			
		Yes	−0.751	−1.357	−0.145	0.016*
	ACS	No	ref.			
		Yes	−0.692	−1.56	0.176	0.119
	TD	No	ref.			
		Yes	−0.154	−0.751	0.443	0.613
	BMI	18.5–24.9	ref.			
		<18.5	−0.917	−5.286	3.453	0.681
		25.0–29.9	0.047	−0.636	0.731	0.893
		≥30	0.004	−0.706	0.714	0.992
	NRS-2002	<3	ref.			
		≥3	−0.312	−1.183	0.559	0.483
Male	Age	[years]	0.029	0.008	0.05	0.007*
	Type of AF	Paroxysmal	ref.			
		Persistent	−0.612	−1.185	−0.039	0.037*
		Permanent	1.217	0.42	2.014	0.003*
	HF	No	ref.			
		Yes	0.383	−0.323	1.089	0.288
	DM	No	ref.			
		Yes	−0.63	−1.309	0.049	0.07
	CKD	No	ref.			
		Yes	0.764	−0.06	1.587	0.069
	CS	No	ref.			
		Yes	−1.598	−2.459	−0.737	<0.001*
	HT	No	ref.			
		Yes	−0.979	−1.544	−0.414	0.001*
	ACS	No	ref.			
		Yes	0.154	−0.722	1.03	0.731
	TD	No	ref.			
		Yes	−0.181	−0.935	0.573	0.638
	BMI	18.5–24.9	ref.			
		<18.5	−2.594	−6.37	1.182	0.179
		25.0–29.9	−0.001	−0.652	0.649	0.997
		≥30	0.138	−0.539	0.816	0.689
	NRS-2002	<3	ref.			
		≥3	1.285	0.042	2.529	0.043*

B, unstandardized regression coefficient; *p*, multiple linear regression. *Statistically significant ($p < 0.05$). *n*, number of participants; AF, atrial fibrillation; HF, heart failure; CKD, chronic kidney disease; HT, arterial hypertension; DM, diabetes mellitus; CS, cerebral stroke; ACS, acute coronary syndrome; TD, thyroid disease; BMI, body mass index; NRS-2002, Nutritional Risk Score.

study, BMI results were not a factor in the length of hospitalization, it should be noted that many authors show a positive association between the occurrence of AF and obesity, overweight and underweight (37–39). Also, in the study we conducted, there were no deaths; however, it is worth noting that increasingly researchers are pointing to gender differences in the incidence of mortality and the course of atrial fibrillation (40, 41). Renoux et al. showed that AF mortality was higher in males (10.0, 95% CI 9.8 to 10.1) than in females (8.5, 95% CI 8.3 to 8.6) (40). Our findings of gender differences in the effects of BMI and NRS on LOHS in patients with AF justify the need for further prospective studies in this area, highlighting the complexity of factors affecting the length of hospitalization.

4.1. Study limitation

This study had several limitations. The percentage of male patients at risk for malnutrition was low at 3.88%. In addition, due to the study's retrospective nature, among other factors, patients' body composition was not analyzed by electrical bioimpedance or anthropometric measurements were not taken. The patient's body composition was not assessed in the present study, only the NRS-2002 score and BMI. Anthropometric differences between genders may affect prognosis, which may have been a limitation of this study. Due to restrictions on access to patients' data under Polish law, the long-term survival of patients with AF could not be assessed.

5. Conclusion

The risk of malnutrition according to the NRS-2002 directly predicts the length of hospital stays in men but not women. The study did not find a relationship between body mass index and length of hospital stay in both women and men. Because the number of participants were at risk of malnutrition, these results should be interpreted within the context of each patient. Additional independent predictors of length of hospitalization for female patients independent predictors of length of hospitalization are age, persistent AF, hypertension and in male patient's age, persistent AF, permanent AF, history of stroke and hypertension. Undoubtedly, the impact of NRS-2002 and BMI results in patients hospitalized in the cardiology department due to atrial fibrillation relative to sex requires further investigation.

Data availability statement

The original contributions presented in this study are included in the article, further inquiries can be directed to the corresponding author.

Author contributions

AK and MC: conceptualization, methodology, validation, formal analysis, resources, writing-original draft preparation, and writing-review and editing. AK and KŁ: software. MC, BU, AM, KŁ, and JS: investigation. AK: data curation. AK and AM: visualization. MC: supervision. KŁ: project administration. JS: funding acquisition. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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References

1. Hindricks G, Potpara T, Dagres N, Arbelo E, Bax JJ, Blomström-Lundqvist C, et al. Corrigendum to: 2020 ESC guidelines for the diagnosis and management of atrial fibrillation developed in collaboration with the European Association for Cardio-Thoracic Surgery (EACTS): the task force for the diagnosis and management of atrial fibrillation of the European Society of Cardiology (ESC) developed with the special contribution of the European heart rhythm association (EHRA) of the ESC. *Eur Heart J*. (2021) 42:4194. doi: 10.1093/eurheartj/ehab648

2. Benjamin EJ, Muntner P, Alonso A, Bittencourt MS, Callaway CW, Carson AP, et al. Heart disease and stroke Statistics-2019 update: a report from the American Heart Association. *Circulation*. (2019) 139:e56–e528. doi: 10.1161/CIR.0000000000000659

3. Camm AJ, Lip GYH, de Caterina R, Savelieva I, Atar D, Hohnloser SH, et al. 2012 focused update of the ESC guidelines for the management of atrial fibrillation: an update of the 2010 ESC guidelines for the management of atrial fibrillation. Developed with the special contribution of the European heart rhythm association. *Eur Heart J*. (2012) 33:2719–47. doi: 10.1093/eurheartj/ehs253

4. Westergren A, Wann-Hansson C, Börgdal EB, Sjölander J, Strömblad R, Klevsgård R, et al. Malnutrition prevalence and precision in nutritional care differed in relation to hospital volume – a cross-sectional survey. *Nutr J*. (2009) 8:20. doi: 10.1186/1475-2891-8-20

5. Czapla M, Juárez-Vela R, Łokieć K, Wleklik M, Karniej P, Smereka J. The association between nutritional status and length of hospital stay among patients with hypertension. *Int J Environ Res Public Health*. (2022) 19:5827. doi: 10.3390/ijerph19105827

6. Kałużna-Oleksy M, Krysztofiak H, Migaj J, Wleklik M, Dudek M, Uchmanowicz I, et al. Relationship between nutritional status and clinical and biochemical parameters in hospitalized patients with heart failure with reduced ejection fraction, with 1-year follow-up. *Nutrients*. (2020) 12:2330. doi: 10.3390/nu12082330

7. Czapla M, Uchmanowicz I, Juárez-Vela R, Durante A, Kałużna-Oleksy M, Łokieć K, et al. Relationship between nutritional status and length of hospital stay among patients with atrial fibrillation – a result of the nutritional status heart study. *Front Nutr*. (2022) 9:1086715. doi: 10.3389/fnut.2022.1086715

8. Budzyński J, Anaszewicz M. The associations between atrial fibrillation and parameters of nutritional status assessment in the general hospital population – a cross-sectional analysis of medical documentation. *Kardiologia Pol Pol Heart J*. (2017) 75:231–9. doi: 10.5603/KP.a2016.0182

9. Rahman A, Wu T, Bricknell R, Muqtadir Z, Armstrong D. Malnutrition matters in Canadian hospitalized patients: malnutrition risk in hospitalized patients in a tertiary care center using the malnutrition universal screening tool. *Nutr Clin Pract Off Publ Am Soc Parenter Enter Nutr*. (2015) 30:709–13. doi: 10.1177/0884533615598954

10. Sun X, Boyce SW, Hill PC, Bafi AS, Xue Z, Lindsay J, et al. Association of body mass index with new-onset atrial fibrillation after coronary artery bypass grafting operations. *Ann Thorac Surg*. (2011) 91:1852–8. doi: 10.1016/j.athoracsur.2011.03.022

11. Wang X, Zhou C, Li Y, Li H, Cao Q, Li F. Prognostic value of frailty for older patients with heart failure: a systematic review and meta-analysis of prospective studies. *Biomed Res Int*. (2018) 2018:e8739058. doi: 10.1155/2018/8739058

12. Zhao M, Song L, Zhao Q, Chen Y, Li B, Xie Z, et al. Elevated levels of body mass index and waist circumference, but not high variability, are associated with an increased risk of atrial fibrillation. *BMC Med*. (2022) 20:215. doi: 10.1186/s12916-022-02413-1

13. Thacker EL, McKnight B, Psaty BM, Longstreth WT, Dublin S, Jensen PN, et al. Association of body mass index, diabetes, hypertension, and blood pressure levels with risk of permanent atrial fibrillation. *J Gen Intern Med*. (2013) 28:247–53. doi: 10.1007/s11606-012-2220-4

14. Tsang TSM, Barnes ME, Miyasaka Y, Cha SS, Bailey KR, Verzosa GC, et al. Obesity as a risk factor for the progression of paroxysmal to permanent atrial fibrillation: a longitudinal cohort study of 21 years. *Eur Heart J*. (2008) 29:2227–33. doi: 10.1093/eurheartj/ehn324

15. Pathak RK, Middeldorp ME, Meredith M, Mehta AB, Mahajan R, Wong CX, et al. Long-term effect of goal-directed weight management in an atrial fibrillation cohort: a long-term follow-up study (LEGACY). *J Am Coll Cardiol*. (2015) 65:2159–69. doi: 10.1016/j.jacc.2015.03.002

16. Overvad TF, Rasmussen LH, Skjøth F, Overvad K, Lip GYH, Larsen TB. Body mass index and adverse events in patients with incident atrial fibrillation. *Am J Med*. (2013) 126:640.e9–640.e17. doi: 10.1016/j.amjmed.2012.11.024

17. Huxley RR, Misialek JR, Agarwal SK, Loehr LR, Soliman EZ, Chen LY, et al. Physical activity, obesity, weight change, and risk of atrial fibrillation: the atherosclerosis risk in communities study. *Circ Arrhythm Electrophysiol*. (2014) 7:620–5. doi: 10.1161/CIRCEP.113.001244

18. Siddiqi HK, Vinayagamoorthy M, Gencer B, Ng C, Pester J, Cook NR, et al. Sex differences in atrial fibrillation risk: the VITAL rhythm study. *JAMA Cardiol*. (2022) 7:1027–35. doi: 10.1001/jamacardio.2022.2825

19. Wong GR, Nalliah CJ, Lee G, Voskoboinik A, Chieng D, Prabhu S, et al. Sex-related differences in atrial remodelling in patients with atrial fibrillation: relationship to ablation outcomes. *Circ Arrhythm Electrophysiol*. (2022) 15:e009925. doi: 10.1161/CIRCEP.121.009925

20. Kondrup J, Allison SP, Elia M, Vellas B, Plauth M. Educational and clinical practice committee, European Society of Parenteral and Enteral Nutrition (ESPEN). ESPEN guidelines for nutrition screening 2002. *Clin Nutr Edinb Scotl*. (2003) 22:415–21. doi: 10.1016/s0261-5614(03)00098-0

21. WHO Consultation on Obesity (1999: Geneva S, Organization WH. Obesity: Preventing and managing the global epidemic: Report of a WHO consultation. World Health Organization; (2000). Available at: https://apps.who.int/iris/handle/10665/42330. Accessed December 31, 2022

22. Aldaas OM, Lupercio F, Han FT, Hoffmayer KS, Krummen D, Ho G, et al. Meta-analysis of effect of modest (≥10%) weight loss in management of overweight and obese patients with atrial fibrillation. *Am J Cardiol*. (2019) 124:1568–74. doi: 10.1016/j.amjcard.2019.08.009

23. Kang SH, Choi EK, Han KD, Lee SR, Lim WH, Cha MJ, et al. Underweight is a risk factor for atrial fibrillation: a nationwide population-based study. *Int J Cardiol*. (2016) 215:449–56. doi: 10.1016/j.ijcard.2016.04.036

24. Andrade JG, Deyell MW, Lee AYK, Macle L. Sex differences in atrial fibrillation. *Can J Cardiol*. (2018) 34:429–36. doi: 10.1016/j.cjca.2017.11.022

25. Cheng N, Dang A, Lv N, He Y, Wang X. Malnutrition status in patients of very advanced age with nonvalvular atrial fibrillation and its impact on clinical outcomes. *Nutr Metab Cardiovasc Dis NMCD*. (2019) 29:1101–9. doi: 10.1016/j.numecd.2019.06.021

26. Abstract 13638: Protein calorie malnutrition is an adverse prognostic marker in atrial fibrillation patients: An analysis of the National Inpatient Sample Registry|circulation. Available at: https://www.ahajournals.org/doi/abs/10.1161/circ.144.suppl_1.13638. Accessed May 7, 2023

27. Zhu S, Zhao H, Zheng M, Peng J. The impact of malnutrition on atrial fibrillation recurrence post ablation. *Nutr Metab Cardiovasc Dis NMCD*. (2021) 31:834–40. doi: 10.1016/j.numecd.2020.12.003

28. Kim D, Shim J, Kim YG, Yu HT, Kim TH, Uhm JS, et al. Malnutrition and risk of procedural complications in patients with atrial fibrillation undergoing catheter ablation. *Front Cardiovasc Med*. (2021) 8:8:736042. doi: 10.3389/fcvm.2021.736042

29. Rinninella E, Cintoni M, de Lorenzo A, Anselmi G, Gagliardi L, Addolorato G, et al. May nutritional status worsen during hospital stay? A sub-group analysis from a cross-sectional study. *Intern Emerg Med*. (2019) 14:51–7. doi: 10.1007/s11739-018-1944-5

30. Lima J, Teixeira PP, Eckert I Da C, Burgel CF, Silva FM. Decline of nutritional status in the first week of hospitalization predicts longer length of stay and hospital readmission during 6-month follow-up. *Br J Nutr*. (2021) 125:1132–9. doi: 10.1017/S0007114520003451

31. Jackson AS, Stanforth PR, Gagnon J, Rankinen T, Leon AS, Rao DC, et al. The effect of sex, age and race on estimating percentage body fat from body mass index: the heritage family study. *Int J Obes Relat Metab Disord J Int Assoc Study Obes*. (2002) 26:789–96. doi: 10.1038/sj.ijo.0802006

32. Vîjan AE, Daha IC, Delcea C, Dan GA. Determinants of prolonged length of hospital stay of patients with atrial fibrillation. *J Clin Med*. (2021) 10:3715. doi: 10.3390/jcm10163715

33. Odening KE, Deiß S, Dilling-Boer D, Didenko M, Eriksson U, Nedios S, et al. Mechanisms of sex differences in atrial fibrillation: role of hormones and differences in electrophysiology, structure, function, and remodelling. *Eur Eur Pacing Arrhythm Card Electrophysiol J Work Groups Card Pacing Arrhythm Card Cell Electrophysiol Eur Soc Cardiol*. (2019) 21:366–76. doi: 10.1093/europace/euy215

34. Proietti M, Raparelli V, Basili S, Olshansky B, Lip GYH. Relation of female sex to left atrial diameter and cardiovascular death in atrial fibrillation: the AFFIRM trial. *Int J Cardiol*. (2016) 207:258–63. doi: 10.1016/j.ijcard.2016.01.169

35. Kloosterman M, Chua W, Fabritz L, al-Khalidi HR, Schotten U, Nielsen JC, et al. Sex differences in catheter ablation of atrial fibrillation: results from AXAFA-AFNET 5. *Eur Eur Pacing Arrhythm Card Electrophysiol J Work Groups Card Pacing Arrhythm Card Cell Electrophysiol Eur Soc Cardiol*. (2020) 22:1026–35. doi: 10.1093/europace/euaa015

36. Silva RL, Guhl EN, Althouse AD, Herbert B, Sharbaugh M, Essien UR, et al. Sex differences in atrial fibrillation: patient-reported outcomes and the persistent toll on women. *Am J Prev Cardiol*. (2021) 8:100252. doi: 10.1016/j.ajpc.2021.100252

37. Anzai T, Grandinetti A, Katz AR, Hurwitz EL, Wu YY, Masaki K. Paradoxical association between atrial fibrillation/flutter and high cholesterol over age 75 years: the Kuakini Honolulu heart program and Honolulu-Asia aging study. *J Electrocardiol*. (2021) 65:37–44. doi: 10.1016/j.jelectrocard.2020.12.008

38. Bang CN, Greve AM, Abdulla J, Køber L, Gislason GH, Wachtell K. The preventive effect of statin therapy on new-onset and recurrent atrial fibrillation in patients not undergoing invasive cardiac interventions: a systematic review and meta-analysis. *Int J Cardiol*. (2013) 167:624–30. doi: 10.1016/j.ijcard.2012.08.056

39. Goette A, Bukowska A, Lillig CH, Lendeckel U. Oxidative stress and microcirculatory flow abnormalities in the ventricles during atrial fibrillation. *Front Physiol*. (2012) 3:236. doi: 10.3389/fphys.2012.00236

40. Renoux C, Patenaude V, Suissa S. Incidence, mortality, and sex differences of non-valvular atrial fibrillation: a population-based study. *J Am Heart Assoc*. (2014) 3:e001402. doi: 10.1161/JAHA.114.001402

41. Israeli A, Gal D, Younis A, Ehrenberg S, Rozner E, Turgeman Y, et al. Sex-differences in atrial fibrillation patients: Bias or proper management? *Vasc Health Risk Manag*. (2022) 18:347–58. doi: 10.2147/VHRM.S366285

8 Wyniki i podsumowanie

W publikacji *Sex-related differences in the impact of nutritional status on in- hospital mortality in heart failure: a retrospective cohort study* oceniono różnice płci we wpływie stanu odżywienia na śmiertelność wewnątrzszpitalną z powodu HF. Porównując grupy względem płci wykazano, że kobiety były istotnie statystycznie starsze od mężczyzn (74,67±11,15 vs. 66,76±17,78; p<0,001), częściej chorowały na HFpEF niż mężczyźni (p<0,001), istotnie częściej miały wyższą klasyfikację HF wg New York Heart Association (NYHA) (p<0,001), częściej chorowały na TD (p<0,001), CKD (p<0,023). Przedstawione wyniki ukazują, że wśród kobiet z otyłością istotnie częściej występowało CKD (p<0,019), HT (p<0,002) oraz DM (p<0,017) niż u pacjentek z nadwagą lub prawidłową masą ciała, były one również istotnie młodsze (p=0,007). Z kolei mężczyźni z otyłością istotnie rzadziej umierali w szpitalu (p<0,003), byli istotnie młodsi (p<0,008) oraz częściej rozpoznawano u nich HFpEF (p<0,020), HT (p<0,016) oraz DM (p<0,001) niż u pacjentów płci męskiej z nadwagą lub prawidłową masą ciała.

Kobiety, które uzyskały wynik NRS≥3 pkt miały istotnie częściej wyższą klasę NYHA (p<0,004) oraz niższe BMI (p<0,011) niż osoby bez ryzyka niedożywienia. Mężczyźni z NRS≥3 pkt byli istotnie starsi (p<0,001), istotnie częściej rozpoznawano u nich wyższą klasę NYHA (p<0,014), mieli istotnie niższe BMI (p<0,001) oraz istotnie częściej niż pacjenci niezagrożeni niedożywieniem umierali w szpitalu (p<0,001).

W celu zbadania wpływu wyniku BMI i NRS-2002 na śmiertelność wewnątrzszpitalną u pacjentów z HF wykonano trzy modele regresji logistycznej: model nieskorygowany, model skorygowany o wiek oraz model skorygowany o wszystkie dostępne zmienne.

Nieskorygowany wieloczynnikowy model regresji logistycznej nie wykazał, aby wynik BMI lub NRS-2002 był predyktorem szansy zgonu wewnątrzszpitalnego wśród kobiet.

Natomiast pośród mężczyzn BMI<18,5 podnosiło szanse zgonu wewnątrzszpitalnego 14.81 razy (OR=14.81, p=0,001) a wynik NRS≥3 pkt niemalże dziewięciokrotnie (OR=8.979, p<0,001). W modelu skorygowanym o wiek, wpływ wyniku BMI i NRS-2002 nadal pozostawał nieistotny statystycznie w przypadku kobiet. Niezależnym predyktorem długości hospitalizacji w tej grupie był wiek (OR=1,052, p=0,035). U pacjentów płci męskiej z BMI<18,5 szanse zgonu wewnątrzszpitalnego były ponad 15 razy większe w stosunku do mężczyzn o prawidłowej masie ciała (OR=15.423, p=0,001). Dodatkowo wynik NRS≥3 podnosił te szanse ponad pięciokrotnie (OR=5.557, p=0,002). Niezależnym predyktorem długości hospitalizacji był również wiek (OR=1,054, p=0,009). W modelu trzecim, skorygowanym o wszystkie zmienne, stan odżywienia nie wpływał na śmiertelność wewnątrzszpitalną u kobiet. W tej grupie istotnymi niezależnymi predyktorami szansy zgonu wewnątrzszpitalnego był: wiek (OR=1.087, p=0,016), klasa NYHA III (OR=0,176, p=0,021) oraz współistniejąca DM (OR=7,455, p=0,008). W przypadku mężczyzn zarówno wynik BMI<18,5 (OR=15,978, p=0,007), jak i NRS≥3 (OR=4,686, p=0,015) w dalszym ciągu podnosiły szanse zgonu podczas hospitalizacji.

W publikacji *Sex-related differences in the impact of nutritional status on in-hospital mortality in acute coronary syndrome: a retrospective cohort study* oceniono różnice płci we wpływie stanu odżywienia na śmiertelność wewnątrzszpitalną u pacjentów z AMI. Porównanie cech pacjentów ze względu na płeć wykazało, że kobiety były istotnie starsze od mężczyzn (73,24±11,81 vs 67±11,81) oraz istotnie częściej występowały u nich: CKD (p<0,001), HT (p<0,001) oraz DM (p=0,002), istotnie częściej narażone były również na otyłość (p=0,012). Pacjentki z BMI≥30 istotnie częściej chorowały na HT (p=0,003) i DM (p<0,001) w porównaniu z pacjentkami z BMI<30. U mężczyzn z BMI≥30 częściej występowały choroby współistniejące, takie jak

HT (p=0,005) i DM (p<0,001). Byli także istotnie młodsi (p=0,021) w porównaniu z pacjentami płci męskiej z BMI<30. Kobiety z NRS≥3 były istotnie starsze (p=0,001), istotnie rzadziej występowało u nich HT (p=0,042) i DM (p=0,014) oraz miały istotnie niższe BMI (p=0,027) niż osoby niezagrożone niedożywieniem. W tej grupie stwierdzono również istotnie wyższą śmiertelność wewnątrzszpitalną (p<0,001). Mężczyźni, u których stwierdzono wynik NRS≥3 byli istotnie starsi (p=0,001), dłużej przebywali w szpitalu (p=0,001), rzadziej występowała u nich HF (p=0,001) oraz hipercholesterolemia (p=0,016) w porównaniu do mężczyzn z NRS<3. W celu zbadania wpływu wyniku BMI i NRS-2002 na śmiertelność wewnątrzszpitalną, u pacjentów z AMI wykonano dwa modele regresji logistycznej: model nieskorygowany oraz model skorygowany o wszystkie dostępne zmienne. W modelu nieskorygowanym u pacjentek z NRS≥3 szansa zgonu wewnątrzszpitalnego była ponad siedmiokrotnie wyższa (OR=7,51, p=0,001) w porównaniu do pacjentek niezagrożonych niedożywieniem. W przypadku mężczyzn stan odżywienia nie wpływał na śmiertelność wewnątrzszpitalną. W modelu skorygowanym o wszystkie dostępne zmienne w przypadku kobiet, zarówno NRS≥3 (OR=6,555, p=0,007), jak i współistniejąca HF (OR=8,408, p=0,003) były niezależnymi predyktorami zwiększającymi szanse zgonu wewnątrzszpitalnego. W przypadku mężczyzn wieloczynnikowy model regresji logistycznej pokazał, że istotnym niezależnym predyktorem szansy zgonu wewnątrzszpitalnego jest współistniejąca HF (OR=3,789 p=0,006). Wynik BMI i NRS w tej grupie nie wpływał na śmiertelność wewnątrzszpitalną.

W publikacji *Sex-related differences in the impact of nutritional status on length of hospital stay in atrial fibrillation: a retrospective cohort study* oceniono wpływ stanu odżywienia na LOHS u pacjentów z AF. W tej grupie badanych kobiety były istotnie starsze od mężczyzn (72,94±9,56 vs. 65,11±12,68, p<0,001), istotnie częściej chorowały na CKD (p=0,005), TD (p<0,001) oraz przebyły CS (p=0,05). W grupie kobiet występowało większe ryzyko niedożywienia (11,09% vs. 3,99%, p<0,001). Kobiety z BMI≥30 były istotnie młodsze (p<0,001), istotnie częściej chorowały na DM (p<0,008) w porównaniu do pacjentek z BMI<30. Także istotnie częściej niż kobiety z BMI<30 prezentowały przetrwałe AF (p<0,001). Mężczyźni z BMI≥30 byli istotnie młodsi (p<0,001) oraz istotnie częściej prezentowali przetrwałe AF (p<0,001) w porównaniu do mężczyzn z BMI<30.

W celu zbadania wpływu wyniku BMI i NRS-2002 na LOHS u pacjentów z AF wykonano trzy modele regresji liniowej: model nieskorygowany, model skorygowany o wiek oraz model skorygowany o wszystkie dostępne zmienne. W przypadku kobiet nieskorygowany wieloczynnikowy model regresji liniowej nie wykazał, aby któraś z analizowanych cech była istotnym niezależnym predyktorem LOHS. Pośród mężczyzn ryzyko niedożywienia wydłużało hospitalizację średnio o 1,95 dnia. (B=1,95; p=0,003). Nie wykazano, aby wynik BMI wpływał na LOHS w tej grupie pacjentów.

W modelu regresji liniowej skorygowanej o wiek w przypadku kobiet ani BMI, ani NRS nie było niezależnym predyktorem LOHS u kobiet. Natomiast pośród mężczyzn wynik NRS≥3 pozostał istotnym niezależnym predyktorem LOHS (B=1,843, p=0,005), co wydłużało hospitalizację średnio o 1,843 dnia. Wynik BMI nadal pozostawał bez wpływu na LOHS. W modelu trzecim, skorygowanym o wiek i choroby współistniejące w przypadku pacjentek istotnymi niezależnymi predyktorami LOHS był: wiek (B=0,075), przetrwałe AF (B=0,717) i HT (B=-0,751). Nie wykazano wpływu wyniku BMI i NRS na LOHS. U mężczyzn niezależnymi predyktorami LOHS okazały się: wiek (B=0,029), przetrwałe AF (B=−0,612), utrwalone AF (B=1,217), przebyty udar (B=−1,598) i HT (B=−0,979). NRS≥3 nadal pozostał niezależnym czynnikiem wpływającym na długość hospitalizacji (B=1,285, p=0,043). Wynik BMI pozostał bez wpływu w tej grupie.

Różnice płci we wpływie stanu odżywienia na śmiertelność wewnątrzszpitalną u pacjentów z CVD oceniono w niewielu pracach. W badaniu Pan i wsp. scharakteryzowano specyficzne dla płci ryzyko wystąpienia chorób CVD oraz śmiertelności i odnotowano znacznie wyższe ryzyko zgonu u mężczyzn [39]. Lepsze zrozumienie różnic między płciami może mieć kluczowe znaczenie w dostosowaniu odpowiednich strategii terapeutycznych oraz ocenie ryzyka i rokowań chorych. Dotychczasowe badania, które dotyczyły wpływu stanu odżywienia na rokowania u pacjentów z HF, AMI i AF wykazują zarówno zależności liniowe, jak i w kształcie litery „U" [40-41]. Wyniki badań własnych nie wykazały wpływu otyłości wg. BMI na śmiertelność i długość hospitalizacji wśród badanych. W dostępnej literaturze zauważa się jednak tzw. „paradoks otyłości", szczególnie wśród pacjentów z HF, choć niedawne badania wskazują, że alternatywne dla BMI pomiary antropometryczne nie potwierdzają jego istnienia, a większa otyłość jest wyraźnie powiązana z większym ryzykiem hospitalizacji z powodu HF [42]. Wykazany w pracy własnej zależny od płci wpływ złego stanu odżywienia na rokowania pacjentów z CVD rzuca nowe światło na konieczność monitorowania stanu odżywienia oraz ryzyka niedożywienia. Ocena ta powinna stanowić integralną część procesu terapeutycznego i być wykonywana zarówno w momencie przyjęcia pacjenta do szpitala, jak i w trakcie hospitalizacji. Dobór odpowiednich działań i interwencji wobec pacjentów niedożywionych powinien być częścią procesu terapeutycznego, ponieważ wczesne wprowadzanie leczenia żywieniowego może mieć wpływ na ich rokowanie [43-44].

Opisane badanie miało pewne ograniczenia. Jednym z nich była mała grupa pacjentów zagrożonych niedożywieniem. Z uwagi na retrospektywny charakter badań nie dokonano oceny składu ciała pacjenta za pomocą metody bioimpedancji elektrycznej ani pomiaru stosunku obwodu talii do bioder, nie oceniano również występowania otyłości centralnej. Różnice antropometryczne między płciami mogą wpływać na rokowanie pacjentów, mogło to stanowić ograniczenie badania. Ze względu na ograniczenia w dostępie do danych pacjentów na mocy polskiego prawa, nie można było ocenić długoterminowego przeżycia pacjentów.

9. Wnioski

W badanej grupie:

1. Ryzyko niedożywienia oceniane za pomocą skali NRS-2002 oraz niedowaga wg BMI były niezależnymi predyktorami szansy zgonu wewnątrzszpitalnego u mężczyzn z HF. W przypadku kobiet nie wykazano takiej zależności.
2. Ryzyko niedożywienia ocenione za pomocą skali NRS-2002 było czynnikiem zwiększającym szansę zgonu wewnątrzszpitalnego u kobiet z AMI. W przypadku mężczyzn takiej zależności nie wykazano. Nie stwierdzono związku pomiędzy wynikiem BMI a śmiertelnością wewnątrzszpitalną zarówno u kobiet jak i mężczyzn z AMI.
3. Ryzyko niedożywienia wg NRS-2002 u pacjentów z AF było niezależnym predyktorem długości hospitalizacji u mężczyzn, ale nie u kobiet. Nie stwierdzono związku pomiędzy BMI a LOHS zarówno u kobiet jak i mężczyzn z AF.
4. Nadwaga i otyłość wg BMI nie była czynnikiem wpływającym na śmiertelność wewnątrzszpitalną zarówno pośród kobiet jak i mężczyzn z HF i AMI oraz nie wpływała na długość hospitalizacji u pacjentów z AF.
5. Wpływ stanu odżywienia na rokowania pacjentów z CVD zależny od płci, różni się w zależności od postawionego rozpoznania.

10.Piśmiennictwo

1. Mensah GA, Roth GA, Fuster V. The Global Burden of Cardiovascular Diseases and Risk Factors. *J Am Coll Cardiol*. 2019;74(20):2529-2532. doi:10.1016/j.jacc.2019.10.009

2. Amin V, Bowes DA, Halden RU. Systematic scoping review evaluating the potential of wastewater-based epidemiology for monitoring cardiovascular disease and cancer. *Sci Total Environ*. 2023;858:160103. doi:10.1016/j.scitotenv.2022.160103

3. Townsend N, Wilson L, Bhatnagar P, Wickramasinghe K, Rayner M, Nichols M. Cardiovascular disease in Europe: epidemiological update 2016. *Eur Heart J*. 2016;37(42):3232-3245. doi:10.1093/eurheartj/ehw334

4. Benjamin EJ, Muntner P, Alonso A, et al. Heart Disease and Stroke Statistics-2019 Update: A Report From the American Heart Association. *Circulation*. 2019;139(10):e56-e528. doi:10.1161/CIR.0000000000000659

5. Lippi G, Sanchis-Gomar F. Global epidemiology and future trends of heart failure. *AME Med J*. 2020;5(0). doi:10.21037/amj.2020.03.03

6. Zuin M, Rigatelli G, Temporelli P, et al. Trends in acute myocardial infarction mortality in the European Union, 2012–2020. *Eur J Prev Cardiol*. 2023;30(16):1758-1771. doi:10.1093/eurjpc/zwad214

7. Cederholm T, Barazzoni R, Austin P, et al. ESPEN guidelines on definitions and terminology of clinical nutrition. *Clin Nutr*. 2017;36(1):49-64. doi:10.1016/j.clnu.2016.09.004

8. Tsai PFJ, Chen PC, Chen YY, et al. Length of Hospital Stay Prediction at the Admission Stage for Cardiology Patients Using Artificial Neural Network. *J Healthc Eng*. 2016;2016:7035463. doi:10.1155/2016/7035463

9. Yang Z wen, Wei X biao, Fu B qi, Chen J yan, Yu D qing. Prevalence and Prognostic Significance of Malnutrition in Hypertensive Patients in a Community Setting. *Front Nutr*. 2022;9:822376. doi:10.3389/fnut.2022.822376

10. Hobkirk JP, Aubert G, Bomer N. Editorial: Micro- and macronutrient malnutrition in cardiovascular disease. *Front Cardiovasc Med*. 2023;10. Accessed December 13, 2023. https://www.frontiersin.org/articles/10.3389/fcvm.2023.1191982

11. Kootaka Y, Kamiya K, Hamazaki N, et al. The GLIM criteria for defining malnutrition can predict physical function and prognosis in patients with cardiovascular disease. *Clin Nutr*. 2021;40(1):146-152. doi:10.1016/j.clnu.2020.04.038

12. Raposeiras RS, Abu AE, Cesp ón FM, et al. Prevalence and Prognostic Significance of Malnutrition in Patients With Acute Coronary Syndrome. *J Am Coll Cardiol*. 2020;76(7):828-840. doi:10.1016/j.jacc.2020.06.058

13. Balayah Z, Alsheikh-Ali AA, Rashed W, et al. Association of obesity indices with in-hospital and 1-year mortality following acute coronary syndrome. *Int J Obes*. 2021;45(2):358-368. doi:10.1038/s41366-020-00679-0

14. Rahman A, Jafry S, Jeejeebhoy K, Nagpal AD, Pisani B, Agarwala R. Malnutrition and Cachexia in Heart Failure. *JPEN J Parenter Enteral Nutr*. 2016;40(4):475-486. doi:10.1177/0148607114566854

15. Krysztofiak H, Wleklik M, Migaj J, et al. Cardiac Cachexia: A Well-Known but Challenging Complication of Heart Failure. *Clin Interv Aging*. 2020;15:2041-2051. doi:10.2147/CIA.S273967

16. Lv S, Ru S. The prevalence of malnutrition and its effects on the all-cause mortality among patients with heart failure: A systematic review and meta-analysis. *PloS One*. 2021;16(10):e0259300. doi:10.1371/journal.pone.0259300

17. Zhao M, Song L, Zhao Q, et al. Elevated levels of body mass index and waist circumference, but not high variability, are associated with an increased risk of atrial fibrillation. *BMC Med*. 2022;20:215. doi:10.1186/s12916-022-02413-1

18. Ma M, Zhi H, Yang S, Yu EYW, Wang L. Body Mass Index and the Risk of Atrial Fibrillation: A Mendelian Randomization Study. *Nutrients*. 2022;14(9):1878. doi:10.3390/nu14091878

19. Aune D, Sen A, Schlesinger S, et al. Body mass index, abdominal fatness, fat mass and the risk of atrial fibrillation: a systematic review and dose–response meta-analysis of prospective studies. *Eur J Epidemiol*. 2017;32(3):181-192. doi:10.1007/s10654-017-0232-4

20. Wang HJ, Si QJ, Shan ZL, et al. Effects of Body Mass Index on Risks for Ischemic Stroke, Thromboembolism, and Mortality in Chinese Atrial Fibrillation Patients: A Single-Center Experience. *PLOS ONE*. 2015;10(4):e0123516. doi:10.1371/journal.pone.0123516

21. Anaszewicz M, Budzyński J. Clinical significance of nutritional status in patients with atrial fibrillation: An overview of current evidence. *J Cardiol*. 2017;69(5):719-730. doi:10.1016/j.jjcc.2016.06.014

22. Visseren FLJ, Mach F, Smulders YM, et al. 2021 ESC Guidelines on cardiovascular disease prevention in clinical practice. *Eur Heart J*. 2021;42(34):3227-3337. doi:10.1093/eurheartj/ehab484

23. Powell-Wiley TM, Poirier CP, Burke VCLE, et al. Obesity and Cardiovascular Disease. *Circulation*. 2021;143(21):e984-e1010. doi:10.1161/CIR.0000000000000973

24. Asad Z, Abbas M, Javed I, Korantzopoulos P, Stavrakis S. Obesity is associated with incident atrial fibrillation independent of gender: A meta-analysis. *J Cardiovasc Electrophysiol*. 2018;29(5):725-732. doi:10.1111/jce.13458

25. Carbone S, Lavie CJ, Arena R. Obesity and Heart Failure: Focus on the Obesity Paradox. *Mayo Clin Proc*. 2017;92(2):266-279. doi:10.1016/j.mayocp.2016.11.001

26. Niedziela J, Hudzik B, Niedziela N, et al. The obesity paradox in acute coronary syndrome: a meta-analysis. *Eur J Epidemiol*. 2014;29(11):801-812. doi:10.1007/s10654-014-9961-9

27. Sandhu RK, Ezekowitz J, Andersson U, et al. The 'obesity paradox' in atrial fibrillation: observations from the ARISTOTLE (Apixaban for Reduction in Stroke and Other Thromboembolic Events in Atrial Fibrillation) trial. *Eur Heart J*. 2016;37(38):2869-2878. doi:10.1093/eurheartj/ehw124

28. Tutor AW, Lavie CJ, Kachur S, Milani RV, Ventura HO. Updates on obesity and the obesity paradox in cardiovascular diseases. *Prog Cardiovasc Dis*. 2023;78:2-10. doi:10.1016/j.pcad.2022.11.013

29. Simati S, Kokkinos A, Dalamaga M, Argyrakopoulou G. Obesity Paradox: Fact or Fiction? *Curr Obes Rep*. 2023;12(2):75-85. doi:10.1007/s13679-023-00497-1

30. Fröhlich H, Frey N, Frankenstein L, Täger T. The Obesity Paradox in Heart Failure: Is It Still Valid in Light of New Therapies? *Cardiology*. 2022;147(5-6):529-538. doi:10.1159/000527332

31. Sato R, von Haehling S. Revisiting the obesity paradox in heart failure: what is the best anthropometric index to gauge obesity? *Eur Heart J*. 2023;44(13):1154-1156. doi:10.1093/eurheartj/ehad079

32. Mikkola TS, Gissler M, Merikukka M, Tuomikoski P, Ylikorkala O. Sex Differences in Age-Related Cardiovascular Mortality. *PLOS ONE*. 2013;8(5):e63347. doi:10.1371/journal.pone.0063347

33. Connelly PJ, Azizi Z, Alipour P, Delles C, Pilote L, Raparelli V. The Importance of Gender to Understand Sex Differences in Cardiovascular Disease. *Can J Cardiol*. 2021;37(5):699-710. doi:10.1016/j.cjca.2021.02.005

34. Lam CSP, Arnott C, Beale AL, et al. Sex differences in heart failure. *Eur Heart J*. 2019;40(47):3859-3868c. doi:10.1093/eurheartj/ehz835

35. Andrade JG, Deyell MW, Lee AYK, Macle L. Sex Differences in Atrial Fibrillation. *Can J Cardiol*. 2018;34(4):429-436. doi:10.1016/j.cjca.2017.11.022

36. Siddiqi HK, Vinayagamoorthy M, Gencer B, et al. Sex Differences in Atrial Fibrillation Risk. *JAMA Cardiol*. 2022;7(10):1027-1035. doi:10.1001/jamacardio.2022.2825

37. Obesity: preventing and managing the global epidemic. Report of a WHO consultation. *World Health Organ Tech Rep Ser*. 2000;894:i-xii, 1-253.

38. Kondrup J, Rasmussen HH, Hamberg O, Stanga Z. Nutritional risk screening (NRS 2002): a new method based on an analysis of controlled clinical trials. *Clin Nutr*. 2003;22(3):321-336. doi:10.1016/S0261-5614(02)00214-5

39. Pana TA, Mamas MA, Wareham NJ, Khaw KT, Dawson DK, Myint PK. Sex-specific lifetime risk of cardiovascular events: the European Prospective Investigation into Cancer-Norfolk prospective population cohort study. *Eur J Prev Cardiol*. Published online November 30, 2023:zwad283. doi:10.1093/eurjpc/zwad283

40. Rhee TM, Lee JH, Choi EK, et al. Increased Risk of Atrial Fibrillation and Thromboembolism in Patients with Severe Psoriasis: a Nationwide Population-based Study. *Sci Rep*. 2017;7:9973. doi:10.1038/s41598-017-10556-y

41. Czapla M, Uchmanowicz I, Juárez-Vela R, et al. Relationship between nutritional status and length of hospital stay among patients with atrial fibrillation – a result of the

nutritional status heart study. *Front Nutr*. 2022;9. Accessed December 13, 2023. https://www.frontiersin.org/articles/10.3389/fnut.2022.1086715

42. Butt JH, Petrie MC, Jhund PS, et al. Anthropometric measures and adverse outcomes in heart failure with reduced ejection fraction: revisiting the obesity paradox. *Eur Heart J*. 2023;44(13):1136-1153. doi:10.1093/eurheartj/ehad083

43. Lim S, Choo EH, Choi IJ, et al. Impact of the risk of malnutrition on bleeding, mortality, and ischemic events in patients with acute myocardial infarction. *Nutr Metab Cardiovasc Dis*. 2023;33(1):65-74. doi:10.1016/j.numecd.2022.10.009

44. Liang L, Zhao X, Huang L, et al. Prevalence and prognostic importance of malnutrition, as assessed by four different scoring systems, in elder patients with heart failure. *Nutr Metab Cardiovasc Dis*. 2023;33(5):978-986. doi:10.1016/j.numecd.2023.01.004

11.Załączniki

11.1 Dorobek naukowy

Mgr Adrian Kwaśny

WYKAZ PUBLIKACJI

1. Publikacje w czasopismach naukowych

1.1 Publikacje w czasopiśmie z IF

Lp	Opis bibliograficzny	IF	Punkty
1	Czapla Michał, **Kwaśny Adrian**, Słoma-Krześlak Małgorzata, Juárez-Vela Raúl, Karniej Piotr, Janczak Sara, Mickiewicz Aleksander, Uchmanowicz Bartosz, Zieliński Stanisław, Zielińska Marzena: The impact of body mass index on in-hospital mortality in post-cardiac-arrest patients - does sex matter?, Nutrients, 2023, vol. 15, nr 15, art.3462 [10 s.], DOI:10.3390/nu15153462	5,9*	140
2.	**Kwaśny A[drian],** Uchmanowicz I, Juárez-Vela R, Młynarska A, Łokieć K, Czapla M. Sex-Related Differences in the Impact of Nutritional Status on In-Hospital Mortality in Heart Failure: A Retrospective Cohort Study. Eur J Cardiovasc Nurs. 2023 May 25:zvad050. doi: 10.1093/eurjcn/zvad050. Epub ahead of print.	2,9*	70
3	**Kwaśny Adrian**, Łokieć Katarzyna, Uchmanowicz Bartosz, Młynarska Agnieszka, Smereka Jacek, Czapla Michał: Sex-related differences in the impact of nutritional status on in-hospital mortality in acute coronary syndrome: a retrospective cohort study, Nutrition Metabolism and Cardiovascular Diseases, 2023, vol. 33, nr 11, s. 2242-2250, DOI:10.1016/j.numecd.2023.06.010	3,9*	100
4	**Kwaśny Adrian**, Łokieć Katarzyna, Uchmanowicz Bartosz, Młynarska Agnieszka, Smereka Jacek, Czapla Michał: Sex-related differences in the impact of nutritional status on length of hospital stay in atrial fibrillation: a retrospective cohort study, Frontiers in Public Health, 2023, vol. 11, art.1223111 [9 s.]. DOI:10.3389/fpubh.2023.1223111	5,2*	100
	Podsumowanie	17,9	410

**IF 2022*

1.2 Publikacje w czasopiśmie bez IF

Lp	Opis bibliograficzny	Punkty
1	**Kwaśny Adrian**, Kulczyński Bartosz: Wybrane interakcje leków z żywnością u osób starszych, Postępy Dietetyki w Geriatrii i Gerontologii, 2017, vol.3 nr 1, s. 15-20 [Publikacja w czasopiśmie spoza listy MNiSW]	5
2	**Kwaśny Adrian**, Czapla Michał: Dietoprofilaktyka i dietoterapia chorób układu krążenia, Medycyna po Dyplomie, 2022, nr monografia 3(10), s. 10-16, [Publikacja w czasopiśmie spoza listy MNiSW]	5
	Podsumowanie	10

2. Monografie naukowe

2.1 Książka autorska

Lp	Opis bibliograficzny
1	Czapla Michał, **Kwaśny Adrian**: Dieta w niewydolności serca : poradnik dla pacjentów, Warszawa 2023, Wydawnictwo Lekarskie PZWL, 150 s., ISBN 978-83-01-23220-7

1

2.2 Książka redagowana -

2.3 Rozdziały

Lp	Opis bibliograficzny	Punkty
1	**Kwaśny Adrian**: Postępowanie żywieniowe w dyslipidemii, W: Żywienie w chorobach serca, (red.) Michał Czapla, Piotr Jankowski, Warszawa 2022, Wydawnictwo Lekarskie PZWL, s. 125-144, ISBN 978-83-01-22334-2	20
	Podsumowanie	20

3. Varia

Lp	Opis bibliograficzny
1	**Kwaśny Adrian**, Tomczyk Anna: Wpływ otyłości na nadciśnienie tętnicze, Współczesna Dietetyka, 2019, nr 25, s. 52-55
2	**Kwaśny Adrian**: Wpływ wybranych czynników na profilaktykę osteporozy, Współczesna Dietetyka, 2019, nr 26, s. 33-37
3	**Kwaśny Adrian**, Tomczyk Anna: Dieta w miażdżycy – przegląd aktualnych badań, Współczesna Dietetyka, 2020, nr 27, s. 52-56
4	**Kwaśny Adrian**: Wybrane aspekty diety w toczniu rumieniowatym układowym, Współczesna Dietetyka, 2020, nr 28, s. 27-29
5	**Kwaśny Adrian**, Rola wybranych składników odżywczych w stwardnieniu rozsianym, Biuletyn Polskie Towarzystwo Stwardnienia Rozsianego Oddział Łódź, 2022, nr 3, s. 20-25

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11.2 Zgoda Komisji Bioetycznej

Opinia Komisji Bioetycznej Nr KB - 837/2022

11.3 Oświadczenia współautorów