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Integrated approach to cardiovascular risk factor management in patient with chronic coronary syndrome

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Author

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2. List of publications included in doctoral dissertation

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3. List of publications included in the thesis

Article type	**Number**	**Impact Factor**	**MNiSW points**
Articles included in the dissertation	2	6.66	280
Summary	2	6.66	280

4. Abbreviations

CHD : Coronary heart disease

EUROASPIRE V : European Action on Secondary and Primary Prevention by Intervention to Reduce Events)

POLASPIRE : Polish Action on Secondary and Primary Prevention by Intervention to Reduce Events

ESC : European Society of Cardiology

CABG : Coronary artery bypass graft

PCI: Percutaneous coronary intervention

ST-EMI : ST-elevation myocardial infarction

CVD : Cardiovascular disease

BMI : Body mass index

HbA1c : Hemoglobin A1c

HADS : Hospital Anxiety and Depression

HRQL : Heart Related Quality of Life

VAS : Visual Analogue Scale

GRRFI : Good recollection of risk factor information

PRRFI : Poor recollection of risk factor information

SBP : Systolic blood pressure

DBP : Diastolic blood pressure

LDL : low-density lipoprotein

HDL :high-density lipoprotein

ACEI : Angiotensin-converting enzyme inhibitors

IBM : International Business Machines

5. Introduction

5.1 Background of study

Despite public concern over the risks of developing cancer, it has been noted in most countries that the public has more to fear from cardiovascular disease (CVD), as cardiovascular-associated death is currently the top global cause of death. Notably, ischemic heart disease is the biggest killer worldwide, contributing to 16% of the world's total deaths. In 2000, a large increase in deaths due to this disease was noticed, with 2 million to 8.9 million deaths due to this disease occurring in 2019 https://www.who.int/news-room/fact-sheets/detail/the-top-10-causes-of-death. Following this, stroke and chronic obstructive pulmonary disease are the second and third leading causes of death, being responsible for approximately 11% and 6% of total deaths, respectively. CVD leads to substantial patient morbidity and, through the management of stroke and heart failure, results in the highest healthcare utilization costs for any disease in many countries.

Cardiovascular diseases (CVDs) are a group of disorders of the heart and blood vessels. Ischemia is a result of poor blood and oxygen supply to an organ (e.g., the heart). The process involves an inadequate blood supply (circulation) to a local area due to a blockage that prevents blood from flowing to the heart or brain. One type of ischemic heart disease is coronary heart disease (CHD) or coronary artery disease, in which a heart problem is caused by the narrowing of coronary arteries that supply blood to the heart muscle, usually due to the build-up of plaque known as atherosclerosis. The blockage of blood flow to the heart muscle may lead to the death of heart muscle cells, which is known as myocardial infarction (MI). Importantly, people who are at the early stage of coronary artery disease often do not experience any symptoms. However, as atherosclerosis progresses, the demand for oxygen by cardiomyocytes may come to exceed the amount of oxygen carried by the blood through the narrowed vessels, producing

myocardial ischemia. This may happen while performing a strenuous physical activity or undergoing emotional stress. Ischemia, if left untreated, may result in heart failure and death.

In Poland, a significant increase in average life expectancy has been reported for both women (from 77.5 years of age to 81.1 years of age) and men (from 66.8 years of age to 73.1 years of age). Despite these gains, Poland still has lower than average values for this measure among EU countries (with life expectancy being 3.2 years lower for men)[1]. It has been noted that the major causes of death in Poland are cardiovascular disease, with 46% of cause-specific deaths occurring due to CVD and 24.5% cause-specific deaths occurring due to cancer in 2010 [2]. Specifically, cardiovascular disease is the most common cause of death for men over 45 and women over 70. Gender remains an independent predictor of cardiovascular mortality, with women tending to die from cardiovascular disease more often than men due to their older age structure [3]. It seems that cardiovascular disease would also pose a great threat to the lives of men if the differences in age structures between both sexes were eliminated. In accordance with this, available data show that the male and female mortality rates in Poland are 109% and 87% higher compared with the mean mortality rates in other countries of the European Union [3]. These percentages can be linked to the shorter average life expectancy by about 3-7 years in Poland compared with that in 15 other European Union countries [1]. Hence, it is worth studying the factors accelerating the progression of cardiovascular disease in this population. Following that, it is important to explore the novel therapeutic approaches as well as preventive strategies used to combat the detrimental effects of CVD.

Cardiovascular disease represents a collection of disorders which are associated with complex interactions between multiple risk factors. A cluster of risk factors, or comorbidities, that accelerates the risk of developing CVD has been known for many years. These risk factors can be divided into two broad categories: non-modifiable and modifiable risk factors. Non-modifiable risk factors comprise age, gender, ethnicity, and family history of CVD. On the other

hand, modifiable risk factors comprise high blood pressure, hyperlipidemia, diabetes, obesity, cigarette smoking, poor diet, and low level of physical activity. In addition, there are a few risk factors that can accelerate the pathological process, such as familial risk (premature CVD in men before 55 years old and women before 65 years old) and diabetes.

On the other hand, recommendations for the management of patients with chronic coronary syndrome emphasize three broad therapeutic strategies. In the most fundamental, patients are encouraged to change unhealthy lifestyle factors or modify their CVD risk factors, such as quitting or reducing smoking, attaining an optimal body weight, consuming a healthy diet, and exercising regularly[4]. Second, medical regimes including several secondary prevention therapies are frequently administrated to patients, frequently including hypertensive or hyperlipidemia-related drugs. These prescribed medications include antiplatelet agents (or oral anticoagulant)s, 3-hydroxy-3-methylglutaryl coenzyme A reductase inhibitors (statins), angiotensin-converting enzyme (ACE) inhibitors, and beta-blockers to reduce risk factors [5]. Finally, patients can benefit from an arterial revascularization procedure to mitigate their symptoms, improve their prognosis, or both [6,7]. In secondary prevention approaches, effort is taken to address risk factors, and a large body of evidence supports the use of each of these therapies for the prevention of recurrent cardiovascular events. The concept of cardiovascular risk factors was first introduced in the Framingham Heart Study, which developed different risk algorithms to support preventive measures in patients. Notably, cardiovascular disease prevention is strongly associated with the concept of risk factors which, when treated or controlled, may attenuate morbidity and mortality.

To achieve better risk factor control, cooperation between healthcare forces and the general population is pivotal to fight against the adverse outcomes of cardiovascular diseases. From a healthcare perspective, promoting behavioral change may attenuate the prevalence of modifiable cardiovascular risk factors. It was demonstrated in the INTERHEART study that

lifestyle changes such as smoking cessation, daily fruit and vegetable consumption, and regular physical activity significantly reduced the risk of myocardial infarction by more than 80% [8]. In a concordant study, experts from the World Health Organization reported [9] that eight important modifiable risk factors—namely, excessive alcohol consumption, smoking, hypertension, obesity, hypercholesterolemia, diabetes mellitus (DM), low fruit and vegetable intake, and low physical activity—cause 61% of cardiovascular deaths and more than three-quarters of cases of coronary heart disease (CHD). Understanding the effects of risk factors is vital to designing and targeting actionable prevention efforts. In general, it is not feasible to measure the effects of risk factors, as some prove to be more amenable to interventions than others. Only some patients can achieve a BMI in their ideal range, suggesting that one intervention model does not fit everyone; thus, finding models applicable to everyone is a daunting task for today's society. This is because assessing and interpreting the effect of risk factors on health outcomes is challenging due to the inherent factors of finding and interpreting evidence regarding risks and their causal associations with disease at the population level. Following that, to avoid any discrepancies, the ESC prevention guidelines recommend that a formal risk assessment be carried out before suggestions or advice are given regarding any specific lifestyle interventions. The tools that are used to assess CVD risk at the baseline level include the Systemic Coronary Risk Estimation-2 (SCORE2) for individuals without prior ASCVD and SMART/SMART-REACH (https://u-perevent.com) for patients with known ASCVD [10]. The results of baseline risk assessment serve as an indicator for the intensity of lifestyle modification a patient requires. One with a higher baseline cardiovascular risk levels requires more profound lifestyle modifications in order to reduce their absolute cardiovascular risk. While the guidelines do not provide any specific or universally applicable threshold for the ASCVD risk reduction "dosage" of lifestyle interventions needed, the intensity of lifestyle interventions should generally increase as ASCVD risk increases [10].

A recent report from the WHO/Europe HEN analyzed several high-quality randomized controlled trials and found that population-level screening for CVD risk factors has no effect on lowering CVD morbidity and mortality at the population level https://www.who.int/europe/news/item/18-01-2021-new-who-report-population-based-screening-for-cardiovascular-disease-risk-factors-does-not-reduce-cvd-mortality. This indicates that a more actionable approach is required to reduce acute cardiovascular mortality. Population-wide public health studies are urgently needed in order to identify the differences in the risk of cardiovascular disease through a comparative risk assessment framework similar to that of the Global Health risk report [9]. Although cardiovascular risk events are less common in people at low risk, no level of risk can be considered "safe". Population-wide public health improvement efforts are needed to control CVD events in people with low, moderate, and other levels of risk. In addition, public health approaches can effectively reduce the development of recurrent events as well as decrease the likelihood of future CVD epidemics. Overall, preventing cardiovascular disease depends to a large extent on treating or controlling the latter type of risk factors in order reduce the likelihood and improve the outcome of the disease. Preventive strategies are crucial in order to reduce patients' overall CVD risk. Systematic access to secondary prevention control programs for chronic coronary syndrome such as cardiac rehabilitation or other novel programs could benefit individuals who have suffered from multiple recurrent acute events and hence prevent unnecessary premature death. In this study, we explore how these interventions and strategies work in Poland through the POLASPIRE database, a Polish subset of EUROASPIRE (European Action on Secondary and Primary Prevention by Intervention to Reduce Events).

Cardiac rehabilitation (CR) is an integral element of secondary prevention, helping to improve risk control as well as reducing the hospital readmission rate and increasing survival in coronary heart disease (CHD) patients. In 1993, the World Health Organization [11] described cardiac

rehabilitation as: “The sum of activities required to influence favorably the underlying cause of the disease, as well as to provide the best possible physical, mental and social conditions, so that the patients may, by their own efforts, preserve or presume when lost as normal a place as possible in the community. The process includes the facilitation and delivery of prevention strategies”. Later it was added that “rehabilitation cannot be regarded as an isolated form or stage of therapy but must be integrated within secondary prevention services of which it forms only one facet” [12]. At the beginning, this program was only recommended to those after acute myocardial infarction or cardiac surgery which focused precisely on supervised exercise programs. Subsequently, a recently revised practice guideline insisted on the creation of a “comprehensive rehabilitation” program covering multiple aspects including psychological counselling, smoking cessation, dietary intake, weight management, physical activity, and interventions aimed at clinical profile (blood pressure, lipids, and glucose management) in order to allow every CVD patient to keep their cardiovascular risk at an optimized level. In line with that, international guidelines strongly (Class I) recommended that cardiac rehabilitation should be offered to all patients following a planned revascularization procedure, acute coronary syndrome, chronic stable angina, or heart failure [13-16]. Following that, some strong evidence demonstrated that CR participation results in approximately 25% lower mortality and morbidity [17-19]; however, it remains underused worldwide, including in Europe and the USA. Thus far, there has been no multicenter study focused on the efficacy of cardiac rehabilitation programs in Poland. It is unknown whether the use of CR in Poland will have a similar effect as in other European and countries and the United States. The goal of our work is to bring together national CVD associations in this country to standardize the efforts of promoting cardiovascular prevention and rehabilitation in all centers/hospitals. With that, we endeavor to examine in more detail two important preventive strategies: how cardiac rehabilitation programs and physician–

patient communication, from the patient's perspective, affect lifestyle and risk factor management in chronic coronary syndrome patients.

5.2 Problem statement

CVD leads to substantial morbidity and, through the management of stroke and heart failure, results in the highest healthcare utilization costs for any disease in many countries. It is estimated that nearly 50% of the Polish population will die of coronary heart disease (CHD) [2]. Specifically, cardiovascular disease is the most common cause of death for men over 45 and women over 70 years of age [20]. Recently, a series of epidemiological reports on the secondary preventive management of cardiovascular disease have been released [21]; however, their results are not particularly compelling, as the large majority of coronary patients have unhealthy lifestyles in terms of smoking, diet, and sedentary behavior, which negatively impacts the major cardiovascular risk factors. It was also demonstrated in these reports that the majority of patients did not achieve their blood pressure, low-density lipoprotein cholesterol, and glucose targets. Hence, there is a need for improvement in strategies concerning cardiovascular preventive approaches, requiring modern preventive cardiology programs delivered by interdisciplinary teams of healthcare professionals addressing all aspects of lifestyle and risk factor management in order to combat the risk of recurrent cardiovascular events. Recently, a managed care program in acute myocardial infarction survivors was carried out between October 1, 2017, and December 31, 2018 [22]. A one year follow-up of these patients reported that participation in this program may improve prognosis, as it can facilitate access to cardiac rehabilitation and provide a higher standard of outpatient cardiac care. Current managed care program analyses do not carefully consider patients' lifestyles, physical activity backgrounds, quality of life, and prescription rates for cardio-protective drugs. To the best of our knowledge, a multicenter approach aiming to access the effectiveness of cardiac rehabilitation would be very helpful in allowing us to capture the frequency of referrals to cardiac rehabilitation in Poland.

5.3 Justification of the study

Although cardio-protective medications are frequently administrated to treat patients with chronic coronary syndrome, the risk factor control of CVD has been stated to be poor and the majority of patients find it difficult to adhere to recommended lifestyle changes, thus failing to achieve secondary prevention goals in terms of smoking, healthy eating, weight management, and sedentary lifestyle [23].To the best of our knowledge, there are no recently published multicenter observational studies that assess the efficacy of cardiac rehabilitation or patient–doctor communication in the secondary prevention of cardiovascular disease in patients from Poland. We specifically focused on the effects of cardiac rehabilitation and patient–doctor communication on secondary prevention goals. Only a few studies concerning this topic have been conducted, often with a single center[22]. Therefore, this study provides information on intervention strategies and associated secondary prevention goal achievements in chronic coronary syndrome patients. The results from our research using POLASPIRE cross-sectional surveys have proven most helpful for counselling chronic coronary syndrome patients during the process of decision-making regarding suitable intervention strategies and allow patients to make informed choices.

6. Discussion of the articles included in dissertation

6.1 Aims

The aim of this study was to assess the secondary preventive strategies used in chronic coronary syndrome patients. Our specific objectives were:

1. To study the impact of cardiac rehabilitation on risk factor management in a real-life multicenter registry of patients with ischemic heart disease.
2. To address potential characteristics associated with a patient's recollection of physician information and lifestyle changes in chronic coronary syndrome patients.

6.2 Materials and methods

6.2.1 Description of study cohort

Polish Action on Secondary and Primary Prevention by Intervention to Reduce Events (POLASPIRE)

This observational study was carried out in a group of 1236 patients included in the multicenter, cross-sectional POLASPIRE study (Polish Action on Secondary and Primary Prevention by Intervention to Reduce Events). Additionally, it was an extension of the larger EUROASPIRE V study (European Action on Secondary and Primary Prevention by Intervention to Reduce Events), coordinated by the European Society of Cardiology. Patient recruitment was conducted between 2016 and 2017 from four geographical areas (Krakow, Katowice, Warszawa, Bialystok), including 14 departments of cardiology and both teaching and non-teaching hospitals. The recruitment process included patients aged between 18 and 80 years who had been hospitalized in the last 6-24 months due to one of the following qualifying incidents: acute coronary syndrome (ACS), regardless of its treatment (i.e., ST-segment elevation myocardial infarction (STEMI), non-ST segment elevation (NSTEMI)), unstable coronary artery disease (UA), having had elective coronary angioplasty (PCI), or having had elective coronary artery bypass surgery (CABG).

This study involved a two-stage patient selection process. Both stages were performed by centrally trained research personnel. The first part of the study consisted of screening patients' medical histories, which were collected at the time of hospitalization for qualifying incidents. The purpose of the approach was to gather information on the risk factors identified before hospitalization. Data on anthropometric measurements (body weight, height, waist circumstance), blood pressure values, the results of biochemical tests (glucose, HBA1c, creatinine, and plasma lipids), as well as the procedures performed during the patient's hospitalization were obtained. In addition, patients' medication histories and the

pharmacological treatment recommended by their physician on the day of discharge were recorded. Patients eligible for the study were subsequently invited to visit the coordinating center in their region. Patients who agreed to participate in study were interviewed using detailed EUROASPIRE V questionnaires, which consisted of questions on demographic factors, CVD risk factors, education, socioeconomic status, smoking, physical activity, diet, participation in cardiac rehabilitation programs, diabetes training, alcohol consumption, medications, and quality of life after the event. Anthropometric measurements such as waist circumstance, body weight, and height were taken, and blood pressure (average of two measurements) and heart rate were assessed. Laboratory tests were performed, including lipid profile, glucose, creatinine (GFR was calculated using the MDRD formula), and HbA1c tests.

6.2.2 Study variables

We obtained patients' self-reported information on their sociodemographic, medical history, medication intake, lifestyle behavior (dietary pattern, exercise, and smoking status), and quality of life management (Hospital Anxiety and Depression Scale (HADS), Heart-Related Quality of Life (HRQoL), and Euro Quality of life (EQ-5D)) during an interview. Patient body mass index (BMI) was calculated using their height and weight measured in a straight standing position without shoes and heavy items. Obesity was defined as a body mass index (BMI) $\geq 30 kg/m^2$. Low educational attainment was defined as the completion of education at only primary school level or below. Persistent smoker was defined as the patient smoking at the time of the interview or exhaled carbon monoxide exceeding 10 ppm among those reported to be a smoker in the month prior to the index event. Blood pressure was measured twice from the right arm in a sitting position in five-minute intervals, and the mean was used for the analyses. Increased blood pressure was defined as a blood pressure ≥140/90mm Hg. Lipid profile (high-density lipoprotein (HDL) cholesterol, low-density lipoprotein (LDL) cholesterol, triglycerides) and glycated hemoglobin (HbA1c) were measured in fasting venous blood samples taken at the time

of the interview in each of the regional centers. Elevated LDL-c concentration was defined as ≥ 1.8mmol/l and controlled blood glucose level (HbA1c) was accepted as per relevant guidelines as being lower than 7%. For quality of life information, depression and anxiety acquired from HADS scores lower than 8 points were considered normal. The Heart-Related Quality of Life (HRQoL) questionnaire, which consists of two domains, physical (ten items) and emotional (four items), was used. The Euro Quality of life (EQ-5D), a 5-dimension code describing the patient's health state, was converted into a single visual index ranging from "0" to "1" perfect health. A previous study performed in Germany was used as a reference for the purpose of standardization.

6.2.3 Study design

The study design used was that of a cross-sectional study

6.2.4 Ethical consideration

Four regional coordinators were responsible for obtaining approval from local bioethics committees. All participants provided written informed consent.

6.2.5 Statistical analysis performed in study

All analyses in both studies were performed using IBM SPSS statistics software version 22 (IBM, Armonk, New York, USA). As a first step, the distribution of study variables was checked using the Shapiro–Wilk test ($p>0.05$) for normality. Categorical variables were presented in proportions and compared with the Chi square test. Continuous variables were presented in both mean and median values and compared with the Mann–Whitney U test for data without a normal distribution. Student's *t* test was used for continuous variables with a normal distribution. In both studies, we employed a regression model—namely, a logistic regression model and linear regression model—to report demographic, clinical, therapeutics, and risk factors associated with study exposure.

In the study, we assessed the **effects of cardiac rehabilitation on risk factor management and quality of life on patients with ischemic heart disease**. The distribution of covariates varied between groups referred vs. not referred and groups who participated vs. did not participate in CR, which could be due to the distribution not being sensitive to the sample size, leading to an imbalance overall. In a clinical setting, the probability of one being referred to or participating in CR depends strongly on the decisions of both the physicians and patients. To achieve a proper covariate balance of patient characteristics between groups, we performed 1:1 propensity score matching (PSM) using the nearest neighbor method with a match tolerance of 0.01. Propensity score (PS) matching was used to account for bias that resulted from the imbalanced distribution of covariates between groups who were referred to/participated in CR and who were not referred to/did not participate in CR. The factors that were most likely to influence these decisions and be associated with outcomes were used to calculate the propensity score. We performed backward logistics regression and analyzed the groups who were not referred/did not participate vs. who were referred/participated and who were referred/participated vs. who were referred/did not participate. The variables which were statistically significant ($p<0.25$), such as education status (low level/high level) ($p=0.1$), obesity (yes/no) ($p=0.01$), and center code (teaching hospital/non-teaching hospital) ($p=0.16$), as well as other variables that were clinically relevant (gender (female/male), BMI (continues data), and smoking (non-smoker/former smoker/current smoker)), were included in a logistics regression model to obtain a propensity score for matching. As almost 90% of patients reported hypertension and hyperlipidemia, these variables were not used for matching, with the assumption that they were well distributed across the two groups. The similar propensity score obtained in the two groups assures us that the distribution of the covariates was balanced between the groups; thus, it was possible to select controls from whom the PS were similar to the treated PS, meaning that PS-matched groups could be created. Furthermore, the multiple

imputation method was used to treat missing values (ranging between 5 and 20 percent). All baseline demographic variables, CVD risk factors, and treatment variables mentioned were included in the imputation model, and ten imputation sets were created. We constructed a parsimonious logistics regression model using the mentioned potential variables to predict the likelihood of CR participation in the propensity score as a covariate. Subsequently, the propensity score derived from each imputation dataset/complete data was obtained, and the averaged (pooled) propensity score was used as a covariate to match the controls as well as estimate the treatment effect [24]. Of the initial 1012 patients, we obtained a PSM-matched group of 548 patients, with 274 in the No CR group and 274 in the CR group included in the final analysis. Patients' characteristics were compared between the groups using the chi square test after PSM. The lack of significant differences between the groups suggests that indeed the potential biases were reduced; thus, the internal validity of the study was demonstrated. The extensive generalized linear model (GLE) was used instead of the simple linear regression model to properly account for correlated data due to repeated measurements (pre and post) of the same study subjects. The model included the main effects (attending/not-attending CR and measurement time) as well as interaction term between the main effects to describe the differences between CR groups in the change in their outcome variable over the observation period. Two-tailed p values of less than 0.050 and 95 percent confidence interval for ORs that did not include 1 were considered statistically significant.

In a study that assessed the **recollection of physician information about risk factors and lifestyle changes in chronic coronary syndrome patients,** data on demographics, clinical characteristics, and medication administration were compared between good recollection risk factor information and poor recollection risk factor information using the chi square test for categorical variables and the Mann–Whitney U test for continuous variables. We selected the significant variables and variables with a p-value of <0.25 from the univariable analyses and

included them in a backward multivariable logistic regression model to identify factors associated with a good recollection of physician risk factor information. The differences between the risk factor parameters at the baseline and in the interview for the recollection of a physician's risk factor information status were assessed using a linear regression model. A p-value of less than 0.05 and a 95% CI for an odds ratio that did not include 1 were considered statistically significant.

6.3 Results of effects of cardiac rehabilitation on risk factor management and quality of life in patients with ischemic heart disease: a multicenter cross-sectional study

In this study, we included 1012 patients who were interviewed 6 to 18 months after being discharged from hospital due to their index event and who reported complete information on their participation in CR. The majority of the patients were older, with a median age at the time of hospitalization of 65 years old. Most of the patients were admitted to or received treatment in teaching hospitals (83%). Forty percent of the population were treated with an elective invasive procedure such as percutaneous coronary intervention (PCI). Following that, fewer than sixty percent of the patients presented with other index events: non-ST-segment elevation myocardial infarction (NSTEMI) was seen in 217 patients (21.4%), unstable angina was observed in 215 (21.2%), and ST-segment elevation myocardial infraction (STEMI) occurred in 160 (15.8%). In this cohort, less than forty percent of the patients were referred to a cardiac rehabilitation program. Of these, 76.1% had completed all the recommended sessions. The main factors associated with a physician's referral to a CR program were younger age (median (IQR) age 62 (57-68) years) and being employed (P<0.001). Significant different was observed in CR, rates of referral, and rates of participation between regions. We found that patient clinical presentation played an important role in CR referral. Those with STEMI (P<0.001), who had undergone a CABG (P<0.001), or who had hypertension, as well as those on angiotensin-converting enzyme (ACE) inhibitors (P<0.001), diuretics (P<0.001), and anticoagulants

(P<0.001) at the time of hospital discharge, were more likely to be referred to a CR program. In addition, modifiable CVD risk factors influenced the referral rates for CR. More than thirty five percent of those who were smokers at the time of an index event (35.1%) were referred for CR (P<0.001). Of 360 patients who were referred to a CR program, only one-third (76.1%) participated in the program. Obese patients were twice as likely to participate in CR (OR, 2.32; 95% CI, 1.07-5.0) as non-obese patients. The analysis of secondary prevention risk factor goal achievements in the PSM-matched group revealed that patients who participated in CR were 2-fold more likely to stop smoking (OR, 2.05; 95% CI, 1.33-4.14) and to be able to keep their glucose level under control (OR, 1.70; 95% CI, 1.02-2.83) than those who did not participate in CR. In terms of quality of life, a small gain was observed in the physical domain of the Heart-Related Quality of Life (HQRL) score in patients who participated in CR (β coefficient = 0.12; 95% CI, 0.00-0.24). Subsequently, the effect of CR was assessed by analyzing the changes in clinical parameters (lipid , blood pressure, and body weight profile) before and after the CR referral/participation in a generalized linear model. The results remained unchanged and no significant changes were observed. To validate our method, we additionally performed a sensitivity analysis to examine the effects of PSM compared to conventional methods, showing that both produced similar results.

6.4 Results of recollection of physician information about risk factor and lifestyle changes in chronic coronary syndrome patients

In this study, we included 946 patients with chronic coronary syndrome who had completed the risk factor questionnaire during a face-to-face interview. In general, the frequency of recollection of a physician's risk factor information was nearly fifty percent or more for all risk factors included in the study: high blood pressure (80.1%), high blood cholesterol (73.0%), increased weight (47.9%), diet (48.2%), and having received advice from a professional group (81.4%). More than seventy percent of the coronary heart disease patients had risk factors, such

as hypertension and hyperlipidemia, at the time of the index event. Most of the patients in the study were elderly (median age 65 IQR of 60 to 71), male (71%), had undergone PCI (37.5%), were examined in a teaching hospital (82.2%), and had obtained middle-level education (67.6%). Half of the patient population consisted of those with a good recollection of risk factor information (GRRFI) (n = 501). The factors associated with a GRRFI were self-reported obesity ($p<0.001$), hypertension ($p<0.001$), hyperlipidemia ($p<0.001$), diabetes ($p<0.001$), and the prescription of calcium channel blockers or diuretics ($p<0.001$) compared with those with a poor recollection of risk factor information (PRRFI). Moreover, adjusted multivariable logistics regression incorporating backward logistic model selection demonstrated patients who presented with cardiovascular disease risk factors, such as being obese (OR: 4.41; 95% CI: 3.09-6.30) or having diabetes (OR:4.16; 95% CI: 2.96-5.84), at the time of hospitalization were independently associated with a higher chance of having a GRRFI compared to their PRRFI counterparts. In terms of medication administration, GRRFI was significantly associated with a higher intake of hypertensive medication, such as calcium channel blockers (OR: 1.47; 95%CI: 1.04-2.09) and diuretics (OR: 1.41; 95% CI: 1.03-1.91), compared with PRRFI. In addition, age at index event was an independent predictor of recollection of risk factor information, where patients aged ≥ 65 years were fifty percent less likely to recollect risk factor information compared to younger patients. Analyzing the effect between the recollection of risk factor information and the achievement of secondary prevention goals, we noticed a few interesting details. In an adjusted multivariable model, no statistically significant improvement in secondary prevention goal achievement was observed in patients with a GRRFI compared to those with a PRRFI. Interestingly, those with a GRRFI possessed a statistically significantly improved medication adherence compared with those with a PRRFI, showing a nearly two-fold increase in completing >75% of their course of prescribed antihypertensive drugs (OR:1.80; 95% CI: 1.07-3.03). A good recollection of risk factor information was significantly associated

with improvement in lifestyle changes compared with a PRRFI. For instance, reduction in salt intake (OR: 1.39; 95% CI: 1.02-1.90), reduction in fat intake (OR: 1.90; 95% CI: 1.31-2.76), reduction in sugar intake (OR: 1.63; 95% CI: 1.19-2.24), increase in fruit and vegetable intake (OR: 1.55; 95% CI: 1.12-2.15), increase in fish intake (OR: 1.37; 95% CI: 1.02-1.84), excess alcohol intake (OR: 1.76; 95% CI: 1.34-2.29), actively trying to lose weight (OR: 1.58; 95% CI: 1.16-2.15), and following a special diet to lower blood pressure (OR: 5.87; 95% CI: 3.27-10.54) were all associated. The differences according to demographic characteristics (age and gender) and the recollection of risk factor information were assessed in two subgroups. We observed there were no significant interactions between younger and older patients in terms of lifestyle changes in both unadjusted and adjusted multivariable models. However, a significant interaction between a reduction in fat intake ($p = 0.019$) and gender was observed.

6.5 Discussion

The overall benefits for patients with coronary heart disease are often suboptimal due to the poor implementation of secondary prevention strategies across the world, including in Poland. Our study underlines the missed opportunities from not implementing secondary prevention programs for coronary heart disease in Poland. Subsequently, two preventive strategies which could aid current clinical practice to provide the best preventive strategy to treat patients presenting with coronary heart disease were studied.

First, our investigation provides a picture of cardiac rehabilitation practice and associated outcomes of a multicenter cross-sectional study representing real-world data. The cohort we studied consisted of large patient groups enrolled in various centers with reliable measures following a strong statistical approach to report the effectiveness of cardiac rehabilitation programs in Poland. Our study is novel in the way it outlines the outcomes of CR programs. Physician referral rates to CR programs were extremely low in Poland between 2016 and 2017, being about 35% lower than those reported in European studies. [25,26] Potential explanations for

the exceptionally low rates of CR referral are physicians' prioritization of patients and the limited capacity for CR in the country prior to the introduction of the managed care program. According to the International Council of Cardiovascular Prevention and Rehabilitation (ICCPR)'s global audit carried out in the same year (2016/2017), it was noted that only 56 programs were available in the country at time of our study, with an annual median capacity of 375 patients yearly. However, according to the Global Burden of Disease for the incidence of ischemic heart disease reported in that same year, Poland requires approximately 210,000 more CR places annually to treat these patients, indicating that there is only 1 "spot" in these programs open for every 11 patients with ischemic heart disease [27]. Moreover, significant referral disparities according to geographic variations were observed in this study, implying that the evidence discussed previously could be due to the differences in the capacity of the CR programs in the country. In other parts of world, particularly in the United States, addressing the issue of low rates of participation in CR, we explored the issue of the low CR capacity in this country. There are several proven-effective interventions could increase patient referrals, such as systemic referrals or electronic medical record prompts. However, these interventions can only be implemented where there is sufficient CR capacity to serve referred patients. Hence, based on the described pattern of CR programs and CR capacity, it is important to explore other preventive strategies for managing CVD-associated risk factors in this country. The European Guidelines on the Prevention of Cardiovascular Disease in Clinical Practice issued by the Joint European Societies between 1994 and 2016 aimed to emphasize the importance of adequate management based on appropriate lifestyle changes, the optimal control of risk factors, and the use of cardioprotective drugs [13]. Maintaining a healthy lifestyle in the secondary prevention of coronary heart disease is thought to be equally important as pharmacotherapy, which serves an independent factor to reduce cardiovascular morbidity and mortality [28]. Following that, we investigated how to improve the adherence to a healthy lifestyle by assessing the interaction

between patient and physician, particularly characterizing the features of patients with a poor recollection and good recollection of risk factor information. The prevalence of good recollection risk factor information among chronic coronary patients was highly pronounced in those who presented with multiple comorbidities during their hospital visits. In particular, patients who are obese and have diabetes tend to have a higher intake of medication at hospitalization discharge. In terms of secondary preventive goal achievement, these patients had a better adherence to antihypertensive drugs compared to those who had a poor recollection of risk factor information. This reflects how behavioral changes are important in individuals in order to tailor preventive interventions. In addition, healthcare professionals need to acquire substantial training in order to support patients employing evidence-based approaches to lifestyle changes. [29] In the situation where a country lacks sufficient CR capacity, it is worth exploring other strategies that could provide similar benefits, such as developing home-based CR. Although home-based CR programs are not funded at this time, efforts to increase the feasibility of their implementation by incorporating other aspects such as tailoring the conveyance of information to patients could help patients to incorporate their heart-healthy lifestyle changes into their daily life in their community. Importantly, we identified some potential benefits of CR for both program engagement and patient outcomes, smoking cessation, and blood glucose control. It is of utmost importance to increase awareness among physicians of the need to pay attention to preventive strategies rather than cardioprotective medicine alone. At same time, we should not neglect the opportunities missed by CR programs, as these patients could still benefit from stand-alone home-based services as an adjunct following a CR program. Home-based services should be integrated with comprehensive knowledge about risk factors, incorporating effective communication between multidisciplinary teams and patients.

6.6 Limitation and Strength of the study

Our study analyzed the importance of the use of secondary preventive strategies to achieve secondary prevention goals among heart disease patients through real-world data. This approach provides a thorough understanding of patients' lifestyles and journeys, treatment administration, and patterns of drug effectiveness to capture the reality of day-to-day healthcare [30]. Although randomized controlled clinical trials (RCTs) can provide information on the efficacy of new drugs owing to the superiority of their clinical evidence, a new amendment of the FDA practices encourages the assessment of alternative measures of drug efficacy employing Real-World Data (RWD). Study designs often include a strict inclusion and exclusion criteria, preventing us from recognizing how particular interventions and treatments affect heterogeneous patient populations outside the setting of a clinical trial. This is often applied for elderly patients with severe or rare cases of disease or patients who are under long-term medication or treatment programs who needed to be excluded from trials. Conversely, using real data gives us the ability to understand how these excluded individuals react to interventions, which provides a broader insight into the population studied. However, our study has a few limitations. The results obtained from observational studies should be interpreted cautiously due to recall bias from recollected information. Although we adjusted our analysis for some confounding factors, we had no control over unmeasured confounding factors, which largely involved inherent risk factors, familial hypercholesterolemia, or other hereditary features that may trigger an adverse effect of CVD.

6.6 Conclusion

1. **In general the rate of referrals for CR program** between 2016 and 2017 was relatively low, with only 35.6% of relevant chronic coronary syndrome patients.
2. There were significant disparities in CR referral rates between regions, but little or no difference between teaching and nonteaching hospitals.

3. Cardiac rehabilitation was most often recommended for those with acute myocardial infarction (STEMI, 28.9% and NSTEMI, 28.3%) in current clinical practice.
4. Obesity was more concern about the disease and was strong predictor of participation in CR
5. Patients participated in CR were twice as likely to change lifestyle behaviours by quit smoking and achieve favourable glucose concentration, as well as have an improved quality of life (in the physical domain) than those who did not take part in CR.
6. **The recollection of information on risk factors** in the secondary prevention patients can be still improved.
7. The recollection of lifestyle advice was the lowest in the oldest group and the highest in the middle-aged patients.
8. Being obese or having diabetes was independently associated with a good recollection of a physician's information on risk factors
9. Despite better treatment adherence to antihypertensive drugs being observed in patients with a GRRFI, there was no significant improvement in the quality of life in heart QoL global, physical and emotional compared with those with a PRRFI, but this may be due to the short observation time.
10. While lifestyle behaviour changed significantly with GRRFI between hospitalization and the time of the interview, there was no significant interaction in the age subgroups, but the pattern of fat intake was significantly different between females and males.

7. Articles included in the dissertation

ORIGINAL ARTICLE

Effects of cardiac rehabilitation on risk factor management and quality of life in patients with ischemic heart disease: a multicenter cross-sectional study

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KEY WORDS

cardiac rehabilitation, ischemic heart disease, propensity score matching, risk factors, secondary cardiovascular prevention

EDITORIAL

by Grace, see p. 610

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ABSTRACT

INTRODUCTION While cardiac rehabilitation (CR) improves survival outcomes in patients with ischemic heart disease (IHD), the long-term benefits of short-term programs are still discussed.

OBJECTIVES The aim of the study was to assess the impact of CR on risk factor management in a multicenter real-life registry of patients with IHD.

PATIENTS AND METHODS We included patients aged 80 years or younger who had been hospitalized due to acute coronary syndrome or for a myocardial revascularization procedure and interviewed 6 to 18 months later. Control of risk factors was compared between patients who participated in CR and those who did not. Propensity score matching was used to account for differences in patient characteristics between the groups.

RESULTS Of 1012 interviewed patients (28.6% women), 35.6% were referred for CR and 76.1% of them completed the program. Those referred were younger (P <0.001), employed (P <0.001), have presented with ST-segment elevation myocardial infarction (P <0.001), had hypertension (P <0.001), and were current smokers (P <0.001). Logistics regression revealed that patients who participated in CR were more likely to stop smoking (odds ratio [OR], 2.42; 95% CI, 1.33–4.14), achieve acceptable glucose control (OR, 1.70; 95% CI, 1.02–2.83), and better quality of life (β = 0.12; 95% CI, 0.00–0.24) compared with those who did not participate in CR.

CONCLUSIONS Cardiac rehabilitation is moderately effective if performed only once and without a continuous support program. Further efforts to increase referrals for CR in patients with IHD must be

INTRODUCTION Cardiac rehabilitation (CR) is one of the core elements of secondary prevention in patients with ischemic heart disease (IHD), aiming to improve risk factors, reduce hospital readmission, and produce a more favorable survival outcome. Two large meta-analyses of 34 and 18 randomized controlled trials have shown that CR reduces recurrent cardiovascular events and improves mortality rates in patients with myocardial infarction.[1,2] Moreover, CR has also been shown to improve patients' quality of life and ability to return to work quickly.[3]

WHAT'S NEW?

The benefits of cardiac rehabilitation (CR) programs in the management of risk factors in patients with chronic coronary syndromes is underreported in Poland. This is the first multicenter study to investigate the referral and participation patterns of CR in Poland. We found the rate of referral to CR in Poland was low, particularly in the elderly, unemployed, and in patients after elective percutaneous coronary intervention. There was a significant positive effect of CR on aspects of secondary prevention approximately 1 year after the acute coronary event or elective revascularization: smoking habit, blood glucose level, and quality of life. The observed effects may be limited by the fact that patients only participated in a single course of CR. Therefore, we suggest a single course of CR should be accompanied by a more prolonged schedule to sustain such benefits.

International guidelines recommend that all patients who have had a planned revascularization procedure or have acute coronary syndrome (ACS), chronic stable angina, or heart failure should engage in a CR program to reduce subsequent events.[3,4] Moreover, recently revised practice guidelines urge for a "comprehensive rehabilitation" program covering a range of aspects: exercise training aimed at improving clinical profiles (optimization of blood pressure, lipid and glucose levels, and weight), healthy heart education (appropriate diet and smoking cessation), and psychological counseling to reduce stress and improve quality of life.[3,5,6] These comprehensive efforts are intended to foster better cardiovascular risk management than could be achieved by supervised exercise alone.

In Poland, cardiovascular disease is one of the major causes of mortality, accounting for 46% of total deaths in 2010,[7] with nearly half of these attributable to IHD. To address this serious situation, healthcare experts have been trying to promote a preventive approach through CR and lifestyle changes. In addition, there has been an increase in the efforts to manage care for patients with IHD, including increased access to CR programs.[8] To our knowledge, there are no multicenter studies to investigate disparities in referral rates and participation in CR and the effectiveness of CR in Poland.

However, referrals for CR programs and the impact of such programs in the real world have been suboptimal[9] both in Europe[10] and the USA.[11] A summary of a large cross-sectional survey carried out by the pan-European group, EUROASPIRE (European Action on Secondary and Primary Prevention by Intervention to Reduce Events), reported that CR referral rates and hence participation rates in Europe remain low.[12,13] Thus, there is the need for urgent action to increase referral and enrollment rates in CR programs.

This study assessed the effectiveness of CR in a patient population enrolled in a CR program in 14 cardiology centers from 4 different regions of Poland, all of which participated in the EUROASPIRE.

PATIENTS AND METHODS The POLASPIRE is a parallel program run by Polish centers involved in the EUROASPIRE V. In total, 403 patients chosen from the POLASPIRE survey contributed to the Polish subset of the EUROASPIRE V. The detailed methodology of this survey has been described previously.[14,15] A multicenter cross-sectional study was conducted between 2016 and 2017 on Polish patients from 4 geographical areas (Kraków, Katowice, Warszawa, Białystok) and from 14 cardiology departments. For each department, medical records were reviewed retrospectively of patients aged between 18 and 80 years who had been hospitalized for 1) coronary artery bypass graft surgery (CABG), 2) elective percutaneous coronary intervention (PCI), 3) acute myocardial infarction (*International Classification of Diseases, Tenth Revision* codes I21 and I22), or 4) unstable angina. Eligible patients were invited for an interview and follow-up examination 6 to 18 months after being discharged. In addition to the patients from the EUROASPIRE V database, we also enrolled additional patients from participating centers during the same period, using the same methodology as well as inclusion and exclusion criteria.

All patients provided written informed consent to take part in the study. The study was approved by the local ethics committees in each regional center.

Cardiac rehabilitation management Patients were asked to report their level of participation in CR at the time of the interview using the following options: 1) did not attend; 2) attended at least one session; 3) attended more than half of the sessions; or 4) completed all of the recommended sessions. In Poland, full participation means that patients received a comprehensive program of in-hospital rehabilitation of between 2 to 6 weeks, which included exercise training, dietary guidance, medication review, smoking cessation advice, and stress management. Due to the design of the study and the short duration of enrollment, we only included participants in the treatment group who declared that they completed all of the CR sessions, to reliably assess the effects of CR.

Study variables We used interviews to obtain participants' self-reported information on a range of health and lifestyle-related issues, detailed below. Each patient's body mass index (BMI) was calculated using their height and weight measured in a straight standing position without shoes and heavy items. Obesity was defined as a BMI of 30 kg/m^2 or greater. A low educational level was defined as having completed only primary school level education or less. A persistent smoker was defined as a patient reported to have been a smoker in the month before the index event who was either still smoking at the time of the interview or who had levels of exhaled carbon monoxide exceeding 10 ppm. Blood pressure was

measured twice on the right arm in a sitting position at 5-minute intervals, and the mean was used for analyses. Increased blood pressure was defined as blood pressure of 140/90 mm Hg or greater. Total cholesterol, high-density lipoprotein cholesterol (HDL-C), low-density lipoprotein cholesterol (LDL-C), triglycerides, and glycated hemoglobin (HbA_{1c}) were measured in fasting venous blood samples. An elevated LDL-C concentration was defined as 1.8 mmol/l or greater, and HbA_{1c} was considered acceptable if lower than 7%, as per the relevant guidelines.[5] Depression and anxiety were assessed using the Hospital Anxiety and Depression Scale (HADS) with a score of less than 8 points considered normal. Quality of life was assessed using a Health-Related Quality of Life (HRQoL) questionnaire consisting of 2 domains, physical (10 items) and emotional (4 items). Generic health status was assessed using the EQ-5D questionnaire which comprises a 5-dimension code describing the patient's state of health in 5 domains, which was converted into a single index ranging from "0" (dead) to "1" (perfect health), with Germany used as the country of reference.[16]

Follow-up and outcome assessment The main outcome in this study was the achievement of risk factor management goals and self-reported lifestyle changes at interview. The secondary outcome was interactions between CR participation and time points.

Propensity score matching method We performed propensity score matching (PSM) to account for potential bias resulting from an imbalance in the covariate distribution between the groups that had been referred for and who participated in CR and those who were not referred and did not participate in CR, both of which could be influenced by decisions taken by physicians and patients. We used multivariable logistic regression to obtain a propensity score (PS) for each CR participant and then were able to search the database for nonreferred CR patients with the same or nearly the same PS match.[17] The variables included in generating the PS were age at index event, gender, center code, type of event, education status, obesity, BMI, and smoking status.

Statistical analysis The distribution of study variables was analyzed using the Shapiro–Wilk test, with a P value of less than 0.05 indicating normal distribution. Categorical variables were described using proportion and compared using the χ^2 test. Continuous variables were expressed using mean and median values and compared using the Mann–Whitney test for data without a normal distribution and t test for variables with a normal distribution.

We used the χ^2 test to compare the distribution of the baseline characteristics of patients who had been referred for CR with those not referred for CR. Multivariable logistic regression was used to identify predictors of CR participation in those referred for CR. Univariable logistic and linear regression models were constructed to estimate the effect of CR in those who participated in CR and those who did not participate from the dataset of propensity score-matched groups.

A generalized linear model (GLM) was used, rather than a simple linear regression model, to adequately account for correlated data due to repeated measurements (pre and post) of the same study participants. This model encompassed 3 effects: 1) CR effect describing baseline difference between those who participated in CR and those who did not, 2) time effect describing interview-baseline difference, and 3) the main effect, that is, time-CR interaction effect, which describes whether there is a different time effect in the CR group compared with the no-CR group and highlights the differences in outcome variables during follow-up between the CR groups.

The multiple imputation method was used to deal with missing values (ranging from 5% to 20%). All the variables mentioned were included in the imputation model, and 10 imputation sets were then created.[18,19] The imputation set was used to analyze and report study outcomes in both univariable regression model and GLM.

A 2-tailed P value of less than 0.05, and a 95% CI for odds ratios that did not include 1, were considered statistically significant. All analyses were performed using IBM SPSS statistics software, version 25 (IBM, Armonk, New York, United States).

RESULTS We assessed 1012 patients who were interviewed 6 to 18 months after their index event and who had provided complete information on their participation in CR (TABLE 1). Of these, women accounted for less than 30% of patients. The median age of patients at the time of hospitalization was 65 years, and the majority of the patients had been hospitalized in teaching hospitals (83%). Almost 40% of the patients had been recruited following elective PCI (n = 377). Other common index events were: non–ST-segment elevation myocardial infarction (NSTEMI) in 217 patients (21.4%), unstable angina in 215 (21.2%), and ST-segment elevation myocardial infraction (STEMI) in 160 (15.8%) (TABLE 1). Overall, one-third of patients had been referred for a CR program (35.6%), and 76.1% of these completed all the recommended sessions.

Physicians were more likely to refer younger than older patients (median [IQR] age, 62 [57–68] years vs 67 [61–72] years, respectively), and employed as compared with unemployed patients (P <0.001) to CR. The rates of CR referral and participation differed considerably between regions (FIGURE 1). Clinically, the patients referred were more likely to have presented with STEMI (P <0.001), CABG (P <0.001), or hypertension (P <0.001), and were more likely to be taking angiotensin-converting enzyme (ACE) inhibitors (P <0.001), diuretics (P <0.001), and

TABLE 1 Baseline characteristics and treatment profile of patients referred and not referred for cardiac rehabilitation at the time of hospitalization (continued on the next page)

Variable		Total (n = 1013)	Cardiac rehabilitation status		P value[a]
			Not referred (n = 652)	Referred (n = 361)	
Age at index event		65 (60–71)	67 (61–72)	62 (57–68)	<0.001
Center	Nonteaching hospitals	172 (17)	114 (17.5)	58 (16.1)	0.57
	Teaching hospitals	840 (83)	538 (82.5)	302 (83.9)	
Region	Białystok	238 (23.5)	75 (11.5)	163 (45.3)	<0.001
	Kraków	398 (39.3)	296 (45.4)	102 (28.3)	
	Katowice	150 (14.8)	102 (15.6)	48 (13.3)	
	Warsaw	226 (22.3)	179 (27.5)	47 (13.1)	
Sex	Male	723 (71.4)	458 (70.2)	265 (73.6)	0.25
	Female	289 (28.6)	194 (29.8)	95 (26.4)	
Education status[b]	Primary level	125 (12.5)	84 (12.9)	41 (11.5)	0.52
	Higher level	879 (87.5)	565 (87.1)	314 (88.5)	
	Unknown	8	3	5	
Employment status	Unemployed	663 (66.1)	471 (72.2)	192 (54.7)	<0.001
	Employed	340 (33.9)	181 (27.8)	159 (45.3)	
	Unknown	9	0	9	
Index event	CABG	43 (4.2)	19 (2.9)	24 (6.7)	<0.001
	PCI	377 (37.3)	286 (43.9)	91 (25.3)	
	STEMI	160 (15.8)	56 (8.6)	104 (28.9)	
	NSTEMI	217 (21.4)	115 (17.6)	102 (28.3)	
	UA	215 (21.2)	176 (27.0)	39 (10.8)	
Previous event	CABG	75 (13.6)	58 (14.2)	17 (12)	0.5
	PCI	333 (60.8)	241 (59.2)	92 (65.2)	0.2
	AMI	255 (47)	195 (48.4)	60 (43.2)	0.28
	UA	55 (10.4)	47 (12)	8 (5.7)	0.03
	Angina pectoris	206 (39)	172 (44.1)	34 (24.6)	<0.001
	Stroke	58 (10.7)	45 (11.2)	13 (9.4)	0.55
	PAD	42 (7.8)	33 (8.2)	9 (6.4)	0.49
	Heart failure	40 (7.5)	37 (9.3)	3 (2.2)	<0.001
Smoking habit	Nonsmoker	356 (38.8)	236 (39.5)	120 (37.6)	<0.001
	Former smoker	312 (34)	225 (37.6)	87 (27.3)	
	Current smoker	249 (27.2)	137 (22.9)	112 (35.1)	
	Unknown	54	41	95	
Obesity		395 (39)	265 (40.6)	130 (36.1)	0.05
Weight, kg		82.7 (74–94)	83 (74–93)	82.5 (74–94)	0.86
BMI, kg/m^2		29 (26.2–32.2)	29 (26.2–32.1)	28.9 (26–32.6)	0.96
Diabetes		317 (31.3)	200 (30.7)	117 (32.5)	0.24
Hypertension		880 (87)	587 (90)	293 (81.4)	<0.001
SBP, mm Hg		136 (123–150)	136 (123.5–150)	135 (120.7–150)	0.18
DBP, mm Hg		80 (72–88)	80 (74–88)	80 (71–88)	0.32
Hyperlipidemia		817 (80.7)	524 (80.4)	293 (81.4)	0.51
LDL-C, mmol/l		2.4 (1.8–3.3)	2.4 (1.7–3.2)	2.5 (1.9–3.4)	<0.01
HDL-C, mmol/l		1.1 (0.9–1.3)	1.1 (0.9–1.4)	1.1 (0.9–1.3)	0.02
Triglycerides, mmol/l		1.3 (0.9–1.8)	1.2 (0.9–1.8)	1. 3 (0.9–1.8)	0.38

TABLE 1 Baseline characteristics and treatment profile of patients referred and not referred for cardiac rehabilitation at the time of hospitalization (continued from the previous page)

Variable		Total (n = 1012)	Cardiac rehabilitation status		*P* value[a]
			Not referred (n = 652)	Referred (n = 360)	
Medication prescribed	Antiplatelets	999 (98.7)	643 (98.6)	356 (98.9)	0.71
	β-Blockers	931 (92)	599 (91.9)	332 (92.2)	0.84
	ACE inhibitors	773 (76.4)	478 (73.3)	295 (81.9)	<0.001
	Statins	960 (94.9)	614 (94.2)	346 (96.1)	0.18
	Calcium channel blockers	272 (26.9)	188 (28.8)	84 (23.3)	0.05
	Diuretics	512 (50.6)	309 (47.4)	203 (56.4)	<0.001
	Anticoagulants	147 (14.5)	114 (17.5)	33 (9.2)	<0.001

Categorical data are presented as numbers (percentages) and continuous data as medians (interquartile ranges).

a *P* values are reported as obtained after exclusion of missing values.

b Primary educational level denotes at most primary school level of education, higher educational level denotes completion of secondary school, high school, technical or vocational training, college, or postgraduate study.

Abbreviations: ACE, angiotensin converting enzyme; AMI, acute myocardial infarction; BMI, body mass index; CABG, coronary artery bypass graft; DBP, diastolic blood pressure; HDL-C, high-density lipoprotein cholesterol; LDL-C, low-density lipoprotein cholesterol; NSTEMI, non–ST-segment elevation myocardial infarction; PAD, peripheral artery disease; PCI, percutaneous coronary intervention; SBP, systolic blood pressure; STEMI, ST-segment elevation myocardial infarction; UA, unstable angina

anticoagulants (P <0.001) at the time of hospital discharge. One-third of smokers at the time of the index event (35.1%) were referred for CR (P <0.001). Among the patients referred for CR, obese patients were twice as likely to participate in CR (OR, 2.32; 95% CI, 1.07–5) than the nonobese. In addition, a higher level of education was marginally associated with CR participation (OR, 2.05; 95% CI, 0.99–4.27) (TABLE 3). After PSM, we revealed that patients who participated in CR were 2-fold more likely to stop smoking (OR, 2.42; 95% CI, 1.33–4.14) and to achieve appropriate glucose control (OR, 1.70; 95% CI, 1.02–2.83) than those who did not participate in CR (TABLE 3). A marginal improvement was observed in the physical domain of the quality of life score in patients who participated in CR (β coefficient = 0.12; 95% CI, 0.00–0.24). Overall, there were no significant changes in lipid concentrations and systolic blood pressure during follow-up that were affected by CR (TABLE 4). We further performed sensitivity analyses to examine the effects of PSM compared to conventional methods, which showed that both produced very similar results.

DISCUSSION We present several findings of interest regarding CR referrals in Poland. First, the rate of referrals between 2016 and 2017 was relatively low, with only 35.6% of relevant cardiac patients referred for CR. Second, there were significant disparities in CR referral rates between regions, but little or no difference between teaching and nonteaching hospitals. Third, CR was most often recommended for those with acute myocardial infarction (STEMI, 28.9% and NSTEMI, 28.3%). Obesity was a strong predictor of participation in CR. Finally, patients who participated in CR were twice as likely to quit smoking, achieve a favorable glucose concentration, and have an improved quality of life (in the physical domain) than those who did not take part in CR.

The challenge is that, despite growing evidence from meta-analyses, systematic reviews, and multicenter studies showing that CR improves the prognosis for IHD patients in terms of reduced hospital readmissions, recurrent events, and mortality,[2,20-22] there is still a low acceptance of CR overall in Poland. Our results confirm that there is a huge gap in referrals and enrollments between hospital discharge and participation in CR. Only just over one-third (35.6%) of study patients were advised to participate in CR after their index cardiovascular event, of whom just under 77% completed full sessions: in other words, fewer than 30% of the study population completed the recommended CR sessions. These figures on CR participation in Poland are even lower than those in both the EUROASPIRE III and IV reports covering 27 countries in Europe, which similarly showed a low proportion of patients (≤50%) being advised to take part in CR and only around one-third doing so.[12,13] These differences in participation levels could be due to the patients' clinical profile, healthcare systems, and the accessibility of CR services in different countries.

Another finding from our study is that CR was most often assigned to patients with acute conditions, particularly those diagnosed with STEMI (65%) or NSTEMI (47%), while the referrals for those who had undergone planned PCI were lower (24.1%). In contrast, a study from the USA using data from the ACTION-Get registry showed that about 50% of patients were referred for CR overall, with enrollment rates of 84.5% for patients with STEMI, 75.9% for those with NSTEMI, and 60% for those having undergone PCI.[23]

TABLE 2 Association between patient characteristics and participation in cardiac rehabilitation in those referred for cardiac rehabilitation

Variable		Overall (n = 360)	Did not participate in CR (n = 86)	Participated in CR (n = 274)	*P* value (group comparison)	Multivariable[a] OR (95% CI)
Age at diagnosis, y		62 (57–68)	62 (58–68)	62 (57–68)	0.92	0.99 (0.96–1.03)
Center	Nonteaching hospitals	58 (16.1)	18 (20.9)	40 (14.6)	0.16	1
	Teaching hospitals	302 (83.9)	68 (79.1)	234 (85.4)		1.7 (0.87–3.29)
Sex	Female	95 (26.4)	19 (22.1)	76 (27.7)	0.3	1
	Male	265 (73.6)	67 (77.9)	198 (72.3)		0.76 (0.42–1.4)
Index event	Planned revascularization	115 (31.9)	28 (32.6)	87 (31.8)	0.88	1
	ACS	245 (68.1)	58 (67.4)	187 (68.2)		1.02 (0.58–1.8)
Education status	Primary level	41 (11.5)	14 (16.5)	27 (10)	0.1	1
	Higher level	314 (88.5)	71 (83.5)	243 (90)		2.05 (0.99–4.27)
	Unknown	5	1	4		–
Occupation status	Unemployed	192 (54.7)	45 (52.9)	147 (55.3)	0.7	1
	Employed	159 (45.3)	40 (47.1)	119 (44.7)		0.9 (0.48–1.66)
	Unknown	9	8	1		–
Smoking habit	Nonsmoker or former smoker	207 (64.9)	46 (63)	161 (65.4)	0.42	1
	Current smoker	112 (35.1)	27 (37)	85 (34.6)		1.04 (0.57–1.87)
	Unknown	41	13	28		–
Hypertension	No	34 (10.4)	10 (12.5)	24 (9.7)	0.47	–
	Yes	293 (89.6)	70 (87.5)	223 (90.3)		
	Unknown	33	6	27		
Hyperlipidemia	No	29 (9)	6 (7.9)	23 (9.3)	0.69	–
	Yes	293 (91)	70 (92.1)	223 (90.7)		
	Unknown	38	10	28		
Obesity	No	159 (55)	47 (67.1)	112 (51.1)	0.01	1
	Yes	130 (45)	23 (32.9)	107 (48.9)		2.08 (1.15–3.76)
	Unknown	71	16	55		–
Diabetes	No	198 (62.9)	46 (60.5)	152 (63.6)	0.62	1
	Yes	117 (37.1)	30 (39.5)	87 (35.4)		0.8 (0.45–1.4)
	Unknown	45	10	35		–

Categorical data are presented as numbers (percentages) and continuous data are presented as median (interquartile range).

a Multivariable model adjusted for: age at index event, center, gender, index event, education status, occupation status, smoking habit, obesity, and diabetes). Missing value was treated as "unknown" subcategory in the multivariable logistics regression model.

Abbreviations: ACS, acute coronary syndrome; CR, cardiac rehabilitation; OR, odds ratio

In summary, there are significant disparities in the levels of CR referral and participation between the USA, Europe, and specifically Poland. What is not clear is whether these low referral and participation rates are due to low physician awareness of the benefits of CR, limited access to CR facilities, patients declining to participate, or a combination thereof. The fact that CR services after ACS or PCI are covered by the public healthcare system in Poland[8] makes it all the more surprising that CR has been so underused. One possible explanation is that, as one of the fastest-aging societies in the EU with 5.9 million people aged 65 years and older,[7] basic healthcare facilities and hospitals may face problems in managing these large numbers of patients and the costs of treatment involved. As a consequence, hospitals may try to keep the number of admissions and basic health care referrals to a minimum, and prioritize those most in need.[7] Also, there is evidence that poor uptake of CR may be due to the reluctance of physicians to refer patients, lack of CR facilities, and/or lack of funding.[1,23,24] In Poland, this was the motivation for the introduction of a country-wide program of managed care after myocardial infarction, including compulsory CR programs.[8] The hope is that this program will improve communication between physicians and patients, which in turn may improve the uptake of CR as well as optimize secondary prevention.

Further noteworthy observations from our study are that younger, employed, smoking patients, and those on ACE inhibitors were more likely to be advised to take part in CR. Advising patients in employment to participate in CR makes sense since CR can help cardiac patients to improve their condition and quality of life to a point where they can go back to work.

TABLE 3 Patient characteristics and risk factors by participation in cardiac rehabilitation at the time of hospital interview using univariable regression model

Variable	No CR (n = 274)	CR (n = 274)[a]	OR (95% CI)[b]	β coefficient (95% CI)[c]	P value
Stopped smoking[d]	31 (33)	49 (54.4)	2.42 (1.33–4.14)	–	<0.001
Physically active[e]	49 (18.6)	36 (13.7)	0.71 (0.44–1.13)	–	0.15
Body weight					
BMI <25 kg/m²	38 (14.1)	40 (14.8)	1.07 (0.66–1.73)	–	0.76
BMI <30 kg/m²	149 (55.2)	158 (58.5)	1.14 (0.81–1.60)	–	0.45
Weight, kg	85.8 (75.3–94.9)	85 (75–94)	–	−0.23 (−2.79 to 2.31)	0.85
BMI, kg/m²	29.4 (26.7–32.7)	29 (26.4–32.5)	–	0.32 (−0.48 to 1.12)	0.43
Blood pressure					
BP <140/90 mm Hg	238 (87.8)	237 (87.5)	0.96 (0.57–1.61)	–	0.89
SBP, mm Hg	131 (120–146)	130 (120–145)	–	−1.06 (−4.29 to 2.16)	0.51
DBP, mm Hg	80 (73–87)	80 (73.5–87.5)	–	0.49 (−1.27 to 2.26)	0.58
Cholesterol control					
LDL-C <1.8 mmol/l	109 (40.7)	95 (35.1)	0.78 (0.55–1.11)	–	0.17
LDL-C, mmol/l	1.9 (1.54–2.6)	2 (1.6–2.59)	–	0.03 (−0.12 to 0.18)	0.7
HDL-C, mmol/l	1.23 (1.06–1.47)	1.24 (1.03–1.49)	–	−0.01 (−0.07 to 0.04)	0.58
Triglycerides, mmol/l	1.29 (0.95–1.79)	1.27 (0.91–1.76)	–	−0.05 (−0.24 to 0.14)	0.59
Glucose control					
HbA_{1c} <7%	195 (81.9)	224 (88.5)	1.7 (1.02–2.83)	–	0.04
HbA_{1c}	6 (5.6–6.4)	5.8 (5.6–6.2)	–	0.02 (−0.46 to 0.52)	0.9
Medication					
Antiplatelets	250 (92.3)	262 (95.6)	1.83 (0.88–3.8)	–	0.1
β-Blockers	235 (86.7)	248 (90.5)	1.46 (0.85–2.49)	–	0.16
ACE inhibitors	192 (70.8)	208 (75.9)	1.29 (0.88–1.89)	–	0.18
Lipid-lowering	241 (88.9)	246 (89.8)	1.09 (0.63–1.88)	–	0.74
Quality of life					
Anxiety HADS <8	8 (3)	10 (3.8)	1.25 (0.48–3.23)	–	0.63
Depression HADS <8	32 (11.9)	39 (14.7)	1.27 (0.77–2.11)	–	0.33
Emotional HRQoL	2 (1.5–2.2)	2 (1.5–2.2)	–	0 (−0.09 to 0.90)	0.94
Physical HRQoL	2.2 (1.7–2.7)	2.4 (1.8–2.8)	–	0.12 (0–0.24)	0.05
EQ-5D QoL	0.9 (0.8–0.9)	0.9 (0.8–0.9)	–	0 (−0.01 to 0.02)	0.65

Categorical data are presented as numbers (percentages) and continuous data are presented as median (interquartile range).

a Completed all the recommended sessions.

b Odds ratio reported for a propensity score-matched population.

c β Coefficients reported for a propensity score-matched population.

d For patients smoking in the month before the recruiting event.

e Patient exercise duration >20 minutes per week.

Abbreviations: BP, blood pressure; HbA_{1c}, glycated hemoglobin; HADS, hospital anxiety and depression scale; HRQoL, health-related quality of life; EQ-5D QoL, Euro quality of life questionnaire of 5 dimension; others, see TABLES 1 and 2

Concerning age, physicians are perhaps less inclined to refer the elderly for CR due to frailty and possible difficulties they might face in commuting to the hospital.[9,25] To reduce these age-related disparities, alternative approaches such as home-based CR for elderly and frail patients should be considered and ideally included in a country-wide program.[26]

Our findings show that more than half of the patients participating in CR were smokers, which is consistent with the results of the EUROASPIRE IV (OR, 1.48; 95% CI, 1.25–1.74). Moreover, those participating in CR were more than twice as likely to give up smoking than non-participants. There is previous evidence from landmark trials that smoking may even outweigh the beneficial effects of statins. These studies showed that the risk of mortality observed in non-smokers not receiving statins was similar to that of smokers on statins.[27] Our results and those of others[15] showing the beneficial impact of CR programs performed in individuals quitting smoking could help boost efforts to encourage more

TABLE 4 Interaction between cardiac rehabilitation participation and time point on risk factors using a generalized linear model

Parameter	No CR (n = 274)		CR (n = 771)		Interaction between CR and measurement time (95% CI)	*P* value[a]
	Baseline	Interview	Baseline	Interview		
Weight, kg	85.9 (15)	85.4 (15)	84.9 (4.9)	85.1 (15.3)	0.32 (–1.58 to 2.23)[b]	0.74
SBP, mm Hg	139 (20)	133 (19)	136 (21)	132 (18)	1.57 (–2.6 to 5.75)[b]	0.46
DBP, mm Hg	82 (11)	80 (10)	79 (12)	80 (10)	3.17 (0.81–5.53)[b]	<0.001
LDL-C, mmol/l	2.7 (1.3)	2.2 (1)	2.7 (1.1)	2.2 (0.9)	–0.02 (–0.25 to 0.2)[b]	0.83
HDL-C, mmol/l	1.2 (0.4)	1.2 (0.3)	1.1 (0.3)	1.2 (0.3)	0.02 (–0.05 to 0.1)[b]	0.52
Triglycerides, mmol/l	1.5 (1.2)	1.5 (1.3)	1.5 (0.9)	1.4 (0.9)	0.00 (–0.2 to 0.13)[b]	0.93
Antiplatelet agent	268 (98.9)	250 (92.3)	270 (98.5)	262 (95.6)	2.42 (0.54–10.9)[c]	0.24
β-Blocker	250 (92.3)	235 (86.7)	253 (92.3)	248 (90.5)	1.44 (0.78–2.66)[c]	0.24
ACE inhibitors	198 (73.1)	192 (70.8)	227 (82.8)	208 (75.9)	0.72 (0.47–1.11)[c]	0.14
Statin	262 (96.7)	241 (88.9)	264 (96.4)	246 (89.8)	1.2 (0.44–3.29)[c]	0.71

Categorical data are presented as numbers (percentages) and continuous data are presented as means (SD).

a *P* value derived from the interaction between cardiac rehabilitation and measurement time point.

b β Coefficient for continuous outcomes.

c Odds ratio for categorical outcomes.

Abbreviations: see TABLES 1 and 2

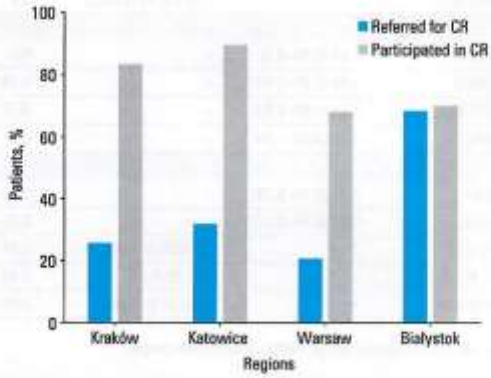

FIGURE 1 Referrals and participation in a cardiac rehabilitation (CR) program by regions. Bars labelled as "Referred for CR" show the percentage of all enrolled patients in that region who were referred to the CR center according to the discharge letter and patient history. Bars labelled as "Participated in CR" present the percent of patients who were referred for CR and who completed a full CR program.

persistent smokers to participate in CR and attend sessions regularly.

Our study confirms positive effects of CR. It showed an approximately 2-fold reduction of average blood glucose levels (HbA_{1c} <7%) in those taking part and completing all the sessions. Moreover, patients who participated in CR showed marginal increases in HRQoL in at least 1 domain. This finding is similar to 2 earlier observational studies that reported significant improvements in quality of life at 6-month[28] and 1-year[29] follow-up. However, neither of these studies adjusted for confounding factors, unlike our study, which applied comprehensive adjustments through the PSM method. Our results therefore provide substantial novel evidence to confirm these findings. However, the observed effects on the attainment of secondary prevention targets are still smaller than expected. We need to search for innovative strategies to improve and sustain the beneficial effects of CR.[30]

This study is subject to several limitations. The main one is potential recall bias, given that the bulk of data on CR participation and its effects was obtained from patients' self-reported questionnaires. Another limitation is that patients volunteered to participate in the study, so individuals more concerned about their health might have been more likely to participate. Finally, since the data was gathered in Poland, the results may not be representative of all countries.

Nonetheless, our findings contribute to the evidence supporting the introduction of the managed healthcare policy for patients with IHD in Poland, which aims to increase CR uptake and participation rates in Poland as well as involving multidisciplinary teams (physicians, nurses, exercise scientists, nutritionists, and psychologists) to improve the prognosis of patients with IHD.[1,21] Our statistical approach, using the PSM method to control confounding variables as well as systematically dealing with missing values using multiple imputations, greatly enhances the statistical power and strength of the study findings, notwithstanding the modest size of the sample groups.

Conclusions The present study showed that a relatively small number of patients with IHD are referred for CR in Poland. Most patients had an improved lifestyle after participation in CR, with the main identified long-term benefits being an increase in the rates of those giving up smoking and a better quality of life score in the physical

domain. Our findings point to an urgent need to incorporate CR into optimized long-term care programs to help sustain the benefits for patients with IHD.

ARTICLE INFORMATION

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CONTRIBUTION STATEMENT SS and KK contributed equally. KK, PJ, SS, JJ, and PS contributed to the conceptualization and design of the study. KK, PJ, ZG, DK, MH, DC, AP, MS, and ML contributed to the data acquisition and interpretation. SS, KK, PS, and JJ contributed to the data analysis and interpretation. The draft manuscript was prepared by SS and KK, and critically checked and approved by KK. All authors critically revised and approved the final manuscript.

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Recollection of Physician Information about Risk Factor and Lifestyle Changes in Chronic Coronary Syndrome Patients

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Abstract: A patient's compliance to a physician's lifestyle information is essential in chronic coronary syndrome (CCS) patients. We assessed potential characteristics associated with a patient's recollection of physician information and lifestyle changes. This study recruited and interviewed patients (aged ≤ 80 years) 6–18 months after hospitalization due to acute coronary syndrome or elective myocardial revascularization. A physician's information on risk factors was recognized if patients recollected the assessment of their diet, weight management, blood pressure control, cholesterol level, diabetes, and other lifestyle factors by the doctor. Of a total of 946 chronic coronary syndrome patients, 52.9% (501) of them declared the recollection of providing information on more than 80% of the risk factors. A good recollection of risk factor information was associated with the following: a patient's age (OR per year: 0.97; 95% CI: 0.95 to 0.99), obesity (OR: 4.41; 95% CI: 3.09–6.30), diabetes (OR: 4.16; 95% CI: 2.96–5.84), diuretic therapy (OR: 1.41; 95% CI: 1.03–1.91), calcium channel blockers (OR: 1.47; 95% CI: 1.04–2.09), and ACEI/sartan (OR: 0.65; 95% CI: 0.45–0.94) at hospitalization discharge. In terms of goal attainment, better adherence to antihypertensive drugs (OR: 1.80; 95% CI: 1.07–3.03) was observed in the patients with a good compared to a poor recollection of risk factor information. The recollection of physician risk factor information was significantly associated with more comorbidities. Strategies to tailor the conveying of information to a patient's perception are needed for optimal patient–doctor communication.

Keywords: chronic coronary syndrome; communication; risk factor information

1. Introduction

A patient's unhealthy lifestyle is known to be the most important modifiable risk factor for the majority of deaths from coronary heart disease (CHD) [1,2]. To reduce the subse-

quent risk of CHD, healthcare professionals often seek an intervention focused on lifestyle modifications, especially in terms of diet, physical exercise, smoking, and weight [3]. With this being the case, an accumulating amount of evidence supports the notion that lifestyle interventions significantly reduce the risk of CHD events [4–8]. Meanwhile, in real life, these interventions are moderate but potentially yield relevant effects in these patients. Lifestyle interventions are most effective when a patient is cooperative and fully involved in the lifestyle modification process, which includes them stopping smoking, practicing a healthy diet, regularly exercising, and monitoring signs of high blood pressure, as well as cholesterol. Yet, adherence to lifestyle advice in clinical practice is not optimal [9].

In Europe, the present prevention approaches of coronary heart disease include advice on changing lifestyles and risk factor management, according to the European Society of Cardiology [5]. Repeatedly, a cardiac rehabilitation and education program has been addressed as a core part of secondary prevention control [10,11]; however, at the time of our study, less than half of the coronary patients had been offered participation in such a program [12]. The recent EUROASPIRE V revealed that the majority of coronary patients have unhealthy lifestyles with low risk factor control (e.g., blood pressure, low-density lipoprotein cholesterol, and glucose targets) [13]. This indicated that there is an urgent need for the implementation of structured, managed care for patients with coronary heart disease, which should be scrutinized by continuing to monitor lifestyle behavior changes to keep cardiovascular risk factors under control.

Patient–doctor interactions are complex, and communicating information about a disease to a patient is challenging [14]. Nevertheless, a significant reduction in an individual's CHD risk requires an appropriate assessment of the risk and effective communication of said risk to anticipate risk factor treatment. Encouraging or motivating patients to change their lifestyle habits requires skills in behavioral science and ample time for physicians to explain the importance of doing so. For instance, this could involve the incorporation of "soft skills" on how to communicate effectively with patients, as well as how to share clinical evidence and explore ways of educating patients to take responsibility and engage in their own care. Additionally, the risk of disease on its own is not effective and needs to be coupled with other intervention elements to promote healthy behavior [15]. Thus, effective communication skills to convey risk in a comprehensible way may provide an important step in obtaining favorable changes in patients' lifestyle habits to combat the subsequent adverse event of the disease [16]. Doctors must also take into consideration a patient's perception of one's health in addition to the predisposition for downplaying possible health threats in some demographic groups (e.g., apparently healthy middle-aged men).

To our knowledge, there are only a few studies that focus on patient–doctor communication in promoting healthy lifestyle behaviors in Europe [17]. Moreover, in clinical practice, not all physicians are well-trained to provide crucial advice to specific groups of patients. Therefore, we planned a study on the efficacy of patient–doctor communication by examining the prevalence of and potential determinants associated with the recollection of lifestyle-associated risk factor information by patients with coronary heart disease. In addition, we sought to address their impact on risk factor goal achievement and lifestyle behavioral changes in secondary prevention.

2. Materials and Methods

2.1. Study Design and Patient Population

We used the POLASPIRE (Polish Action on Secondary and Primary Prevention by Intervention to Reduce Events) database, a Polish survey that contributed to the EUROASPIRE V study, which aimed to recruit coronary heart disease patients from 2016 to 2017 in Poland. This is a cross-sectional study, and it involved 14 hospitals in 4 regions: Cracow, Katowice, Warsaw, and Bialystok. The study screened patients aged >18 years and <80 years who had been hospitalized ≥6 months to <2 years prior due to (i) an elective or emergency coronary artery bypass graft (CABG), (ii) an elective or emergency percutaneous coronary intervention (PCI), (iii) acute myocardial infarction (Interna-

tional Classification of Diseases, Tenth Revision, codes I21 and I22), or (iv) unstable angina in the participating hospitals for eligibility. These patients were invited to participate in a face-to face interview as part of the study. The selection procedure was performed by centrally trained experts. The details of the study methods have been published elsewhere [9,18,19].

2.2. Study Variables

Study variables were collected at two time points: hospitalization (from discharge letters) and at the time of the interview (using EUROASPIRE V questionnaires). These included the presence of risk factors, anthropometric measurements (body weight, height, and waist circumference), blood pressure values, the results of biochemical tests, such as glucose, HBA1c, creatinine, and plasma lipids, the history of CVD-related procedures performed, and the treatment prescribed. Educational level was defined as completion of last education level. Body mass index was calculated as weight divided by height squared, kg/m^2. A patient was defined as obese if their body mass index (BMI) was ≥ 30 kg/m^2. Increased blood pressure was defined as blood pressure $\geq$ 140/90 mm Hg. Patients with cholesterol levels $\geq$ 1.8 mmol/L were noted as having high blood cholesterol, and a controlled blood glucose level (HbA1c) was accepted as that which was lower than 7%, as per guidelines. A current smoker was defined as a patient that reported themselves to be a smoker in the month before the index event, as well as one whose breath carbon monoxide exceeded 10 ppm at the time of the interview. Medication was obtained from discharge letters and was self-reported by patients at the interview. Self-reported information on psychosocial function—depression and anxiety—was assessed using the Hospital Anxiety and Depression Scale (HADS), where a HADS score lower than 8 points was considered as normal. Quality of life was determined by using the Heart-Related Quality of Life (HRQL) questionnaire, which consists of two domains divided by physical (10 items) and emotional (4 items); by calculating the total scores of each, we defined the highest HRQL. In the Visual Analogue Scale (VAS), the score ranged from 0 to 100, and the highest value described a patient's best possible health.

2.3. Strategy in Defining the Exposure Group

The recollection of a physician's information on lifestyle and CVD risk factor management, based on the European Guidelines on CVD Prevention in Clinical Practice [16], was measured via the Polish version of the EUROASPIRE survey questionnaire [12]. A patient's recollection of a physician's clinical risk factor information was categorized based on the amount of information on the management of particular risk factors that the patient recalled from the index hospitalization or cardiac rehabilitation program. These questions were as follows: (1) have you been told SINCE the index event by a health care professional that your diet is unhealthy; (2) have you ever been told by health care professional that you are overweight; (3) have you ever been told by doctor (or other health professional) that you have high blood pressure; (4) have you ever been told by doctor (or other health professional) that you have high blood cholesterol; (5) have you have received lifestyle advices from other professional group; and (6) have you ever been told by a doctor or other health professional that you have diabetes. We calculated the rate of recollection of risk factor and lifestyle items based on a patient's information about risk factor and lifestyle items divided by the potential information or lifestyle items the patient was eligible for. Good recollection of risk factor information (GRRFI) was categorized if a patient recollected risk factors and lifestyle items at a higher rate than the median of all the survey responses, $\geq$80%, and poor recollection of risk factor information (PRRFI) items was when a patient did so at a lower rate than the median, <80%.

2.4. Risk Factor Goal Achievement

The primary assessment was the determinants associated with patient recollection of a physician's risk factor information. The secondary assessment was the measures of self-reported risk factor goal achievement as defined in the 2016 ESC guidelines [6], namely for weight (BMI), blood pressure (SBP and DBP), lipid profile (LDL, HDL, and triglycerides), glucose level (HbA1c), medication adherence, and motivation to change their behavior (e.g., in smoking habits, intake of a healthy diet, weight management, level of physical activity, blood pressure, and cholesterol control strategy). Additionally, we assessed changes in the clinical parameters (e.g., BMI, LDL, HDL, triglycerides, SBP, DBP, and medication intake) between the baseline (at the time of hospitalization) and after 6–18 months (an interview).

2.5. Ethical Statement

All patients provided written informed consent to take part in the study. The study was approved by the local ethics committees in each regional center.

2.6. Data Analysis

Categorical variables were reported in proportions (%), and continuous variables in means and standard deviations. Data on demographics, clinical characteristics, and medication administration were compared between GRRFI and PRRFI using the chi-square (categorical) and Mann–Whitney U tests (continuous). All variables with a p-value of <0.25 in the univariable analyses were included in a backward multivariable logistic regression model to identify factors that were independently associated with a good recollection of a physician's risk factor information. A linear regression model was used to analyze the differences between clinical parameters at the baseline and the interview, as well as the recollection of a physician's risk factor information status. A two-tailed p-value of less than 0.05 and a 95% CI for an odds ratio that did not include 1 were considered statistically significant. All analyses were performed using International Business Machines SPSS Statistics software, version 28 (IBM, Armonk, New York, NY, USA).

3. Results

3.1. Characteristics of the Study Population

The final analysis included 946 chronic coronary syndrome patients after excluding 72 who did not complete the risk factor questionnaire during the face-to-face interview. More than one-third of the hospitalizations in the study cohort were due to a percutaneous coronary intervention (PCI) (37.5%); less than sixty percent had myocardial infarction, namely unstable angina (21.6%), non-ST-segment elevation myocardial infarction (21.1%), and ST-segment elevation myocardial infarction (15.6%), and the least common cause for hospitalization was coronary artery bypass grafting (4.0%). In general, the proportion of recollection of a physician's risk factor information reached nearly fifty percent or more in all of the items included in study: high blood pressure (80.1%), high blood cholesterol (73.0%), increased weight (47.9%), diet (48.2%), and received advice from other professional group (81.4%) (*not shown in table*). More than three-fourths of the coronary heart disease patients had risk factors, such as hypertension and hyperlipidemia, at the time of hospitalization (Table 1).

Table 1. Demographic and Clinical Characteristics of Patients' Recollection of CVD Risk Factor Information from Physicians in Chronic Coronary Syndrome Patients.

Characteristics	Total Patients $n = 946$	Physician Risk Factor Information Recollection		p-Value	Multivariate Odds Ratio (95% CI) [a]
		Poor Recollection $n = 445$	Good Recollection $n = 501$		
Age Group, Years				0.194	
<54	104 (11.0)	51 (11.5)	53 (10.6)		1.00
55–64	349 (36.9)	151 (33.9)	198 (39.5)		0.97 (0.59–1.59)
65–74	379 (40.1)	181 (40.7)	198 (39.5)		0.59 (0.36–0.98)
≥75	114 (12.1)	62 (13.9)	52 (10.4)		0.51 (0.27–0.96)
Gender				0.286	
Female	273 (28.9)	121 (27.2)	152 (30.3)		
Male	673 (71.1)	324 (72.8)	349 (69.7)		-
					-
Center				0.756	
Nonteaching hospitals	162 (17.1)	78 (17.5)	84 (16.8)		-
Teaching hospitals	784 (82.9)	367 (82.5)	417 (83.2)		-
Education Level				0.304	
Primary education	129 (13.6)	55 (12.4)	74 (14.8)		-
Middle education	640 (67.7)	312 (70.1)	328 (65.5)		-
Higher education	177 (18.7)	78 (17.5)	99 (19.8)		-
Recruiting Event				0.087	
CABG	38 (4.0)	21 (4.7)	17 (3.4)		-
PCI	355 (37.5)	157 (35.3)	198 (39.5)		-
ST-EMI	148 (15.6)	73 (16.4)	75 (15.0)		-
Non-ST-EMI	200 (21.1)	84 (18.9)	116 (23.2)		-
UA	205 (21.7)	110 (24.7)	95 (19.0)		-
Smoking Habit				0.152	
Nonsmoker	422 (44.6)	191 (42.9)	231 (46.1)		-
Former smoker	296 (31.3)	134 (30.1)	162 (32.3)		-
Current smoker	228 (24.1)	120 (27.0)	108 (21.6)		-
Obesity				<0.001	
	49				1.00
Yes	370 (39.1)	87 (19.6)	283 (56.5)		4.41 (3.09–6.30)
Unknown	180 (19.0)	87 (19.6)	93 (18.6)		1.07 (0.72–1.59)
Weight, kg	82.75 (74.0, 94.0)	79.0 (70.52, 88.0)	89.0 (79.0, 98.0)	<0.001	-
BMI, kg/m^2	29.03 (26.27, 32.16)	27.73 (25.51, 29.74)	31.0 (28.82, 33.46)	<0.001	-

Table 1. *Cont.*

Characteristics	Total Patients $n = 946$	Physician Risk Factor Information Recollection		p-Value	Multivariate Odds Ratio (95% CI) [a]
		Poor Recollection $n = 445$	Good Recollection $n = 501$		
Hypertension				<0.001	
Yes	863 (91.2)	389 (87.4)	474 (94.6)		
SBP, mm Hg	136.0 (125.0, 150.0)	130.0 (122.2, 146.75)	140 (128.0, 153.5)	0.010	-
DBP, mm Hg	80.0 (73.0, 88.0)	80.0 (72.0, 85.0)	80.0 (74.0, 90.0)	<0.001	-
Hyperlipidemia				<0.001	
Yes	733 (90.6)	328 (87.5)	405 (93.3)		-
LDL-C, mmol/L	2.43 (1.86, 3.39)	2.50 (1.83, 3.39)	2.40 (1.83, 3.34)	0.474	-
HDL-C, mmol/L	1.14 (0.95, 1.39)	1.21 (0.98, 1.45)	1.11 (0.93, 1.34)	0.003	-
Triglycerides, mmol/L	1.30 (0.97, 1.86)	1.22 (0.87, 1.71)	1.38 (1.05, 1.92)	0.007	-
Diabetes				<0.001	
No	628 (66.4)	370 (83.1)	258 (51.5)		1.00
Yes	318 (33.6)	75 (16.9)	243 (48.5)		4.16 (2.96–5.84)
Medication Prescribed					
Antiplatelets	934 (98.7)	441 (99.1)	493 (98.4)	0.338	-
Beta-blockers	867 (91.6)	406 (91.2)	461 (92.0)	0.665	-
ACEI/sartan	722 (76.3)	358 (80.4)	364 (72.7)	0.005	0.65 (0.45–0.94)
Statins	894 (94.5)	420 (94.4)	474 (94.6)	0.878	-
Calcium channel blockers	260 (27.5)	92 (20.7)	168 (33.5)	<0.001	1.47 (1.04–2.09)
Diuretics	466 (49.3)	188 (42.2)	278 (55.5)	<0.001	1.41 (1.03–1.91)
Anticoagulants	139 (14.7)	57 (12.8)	82 (16.4)	0.124	-

All variables were compared using the chi-square test. ST-EMI: ST-elevation myocardial infarction; CABG: coronary artery bypass graft; PCI: percutaneous coronary interventions; UA: unstable angina; primary educational level denoted the completion of primary and secondary school; middle education level denoted the completion of high school or technical/vocational training; and higher education level denoted the completion of college or postgraduate studies. [a] Derived using a backward logistic regression model that included all variables, with $p < 0.25$. The final model comprised age (continuous), gender, center, region, the index event, obesity, hypertension, hyperlipidemia, diabetes, ACEI/sartan, calcium channel blockers, diuretics, and anticoagulants. A missing value was treated as unknown in the multivariable logistic model.

3.2. Patient Characteristics Compared with the Recollection of Risk Factor Information Status (Good Recollection Versus Poor Recollection)

The majority of CCS patients were elderly, with a median age at diagnosis of 65 years (with an interquartile range of 60 to 71), male (71.1%), underwent percutaneous coronary intervention (PCI) (37.5%), were examined in a teaching hospital (82.2%), and had obtained middle-level education (67.6%) (Table 1). Slightly more than half of the patients were identified as having a good recollection of risk factor information ($n = 501$). In addition, good recollection of risk factor information (GRRFI) was significantly associated with self-reported obesity ($p < 0.001$), hypertension ($p < 0.001$), hyperlipidemia ($p < 0.001$), diabetes ($p < 0.001$), and the prescription of calcium channel blockers or diuretics ($p < 0.001$) compared with those with a poor recollection of risk factor information (PRRFI). Education status and smoking habit were not related to the amount of information recalled. A multivariable model was created by including covariates (a patient's demographics, clinical characteristics, and medication intake) as the independent variables and the recollection of risk factor information (RRFI) status as the dependent variable (PRRFI = 0 and GRRFI = 1).

Additionally, by incorporating backward logistics model selection, patients that presented with cardiovascular disease risk factors, such as being obese (OR: 4.41; 95% CI: 3.09–6.30) or having diabetes (OR: 4.16; 95% CI: 2.96–5.84), at the time of hospitalization were independently associated with a higher chance of having a GRRFI compared to their PRRFI counterparts (Table 2). Compared with PRRFI, GRRFI was significantly associated with favorable hypertensive medication administration, such as calcium channel blockers (OR: 1.47; 95% CI: 1.04–2.09) and diuretics (OR: 1.41; 95% CI: 1.03–1.91). (Table 2). The recollection of risk factor information decreased with age (p_{trend} = 0.002), and patients aged ≥ 65 years were fifty percent less likely to recollect risk factor information compared to younger patients.

Table 2. Determinants of Recollection of a Physician's Information on Risk Factors in Chronic Coronary Syndrome Patients.

	Recollection of a Physician's Information on Risk Factors					
Dependent Variables	**Poor Recollection** n = 445	**Good Recollection** n = 501	**OR** [a]	**B** [b]	**95% CI**	***p*-Value**
Risk Factor Goals						
Stopped smoking [c]	58 (50.9)	56 (49.1)	1.48	-	0.85 to 2.60	0.161
Reduction in smoking [c]	77 (61.1)	49 (38.9)	0.41	-	0.23–0.73	0.003
Increased physical activity [d]	68 (15.3)	63 (12.6)	0.77	-	0.50–1.19	0.252
BMI, kg/m^2						
<25	108 (24.3)	35 (7.0)	0.45		0.28–0.71	0.001
<30	332 (74.6)	217 (43.3)	0.52	-	0.37–0.74	0.000
Blood pressure on target [e]	393 (88.9)	427 (85.4)	0.65	-	0.41–1.01	0.058
LDL cholesterol on target [f]	175 (39.8)	180 (36.1)	0.70	-	0.52–0.96	0.028
HbA1c on target [g]	357 (93.5)	351 (77.8)	0.63	-	0.36–1.08	0.097
Antiplatelet, *n*%						
Aspirin	401 (90.1)	439 (87.6)	0.75	-	0.47–1.21	0.247
Clopidogrel	222 (49.9)	233 (46.5)	0.76	-	0.56–1.02	0.068
Lipid-Lowering Drugs, *n*%						
Atorvastatin	292 (65.6)	316 (63.1)	0.90	-	0.66–1.23	0.476
Rosuvastatin	90 (20.2)	120 (24.0)	1.14	-	0.80–1.62	0.456
ACE inhibitors, *n*%	311 (69.9)	354 (70.7)	1.01	-	0.73–1.39	0.951
Beta-blockers, *n*%	385 (86.5)	457 (91.2)	1.16	-	0.72–1.86	0.528
Medication Adherence [h]						
Lipid-lowering drug > 75% intake	385 (88.1)	455 (92.9)	1.46		0.87–2.42	0.145
Antihypertensive drug > 75% intake	372 (85.7)	463 (94.1)	1.80	-	1.07–3.03	0.026
Glucose-lowering drug > 75% intake	103 (23.7)	242 (49.3)	0.81	-	0.48–1.38	0.458

Table 2. *Cont.*

	Recollection of a Physician's Information on Risk Factors					
Dependent Variables	**Poor Recollection $n = 445$**	**Good Recollection $n = 501$**	**OR [a]**	**B [b]**	**95% CI**	***p*-Value**
Quality of life						
HADS—anxiety, mean ± SD	5.70 ± 3.77	5.90 ± 3.54	-	0.35	−0.17 to 0.88	0.184
HADS—depression, mean ± SD	5.45 ± 3.66	5.50 ± 3.36	-	−0.01	−0.51 to 0.49	0.964
Heart QoL [f] global, mean ± SD	29.06 ± 8.41	27.36 ± 9.02	-	−2.08	−3.75 to −0.42	0.014
Heart QoL emotional, mean ± SD	7.70 ± 2.30	7.39 ± 2.31	-	−0.49	−0.94 to −0.05	0.027
Heart QoL physical, mean ± SD	21.37 ± 7.07	20.0 ± 7.66	-	−1.57	−2.97 to 00.16	0.029
VAS overall	0.86 ± 0.12	0.84 ± 0.14	-	−0.02	−0.05 to 0.00	0.068

Proportions for categorical variables, %; BMI, body mass index; CI, 95 percent confidence interval; OR, odds ratio; β coefficient; and significant *p*-value, < 0.05. [a]: multivariable logistics regression adjusted for age at the index event (continuous), gender, the index event, obesity, and diabetes. [b]: multivariable linear regression adjusted for age at the index event (continuous), gender, the index event, obesity, and diabetes. [c]: only patients that reported smoking the month before the index event were included. [d]: active physical activity denoted at least 20 min once or twice a week. [e]: blood pressure ≤ 140/90 mmHg. [f]: LDL-C < 1.80 mml/L. [g]: HBA1c < 7%. [h]: patient reported taking drugs most of time (75%), nearly all of the time (90%), or all the time (100%). Abbreviations: BP, blood pressure; HbA1c, glycated hemoglobin; HADS, Hospital Anxiety and Depression Scale; heart QoL, heart-related quality of life; and VAS, visual analogue score.

In an adjusted multivariable model, created by including RRFI status (PRRFI = 0 and GRRFI = 1) and covariates as the independent variables and risk factor goals as the dependent variables, no statistically significant improvement in secondary prevention goal achievement was observed in patients with a GRRFI compared to those with a PRRFI (Table 2). Compared with PRRFI, GRRFI possesses favorable medication adherence, with nearly a two-fold increase in completing > 75 % of prescribed antihypertensive drugs (OR: 1.80; 95% CI: 1.07–3.03) when the interview was observed. However, quality of life was not improved upon recollecting information on many clinical risk factors and adherence to medication in GRRFI compared with PRRFI. A significant negative association, particularly in heart-related quality of life, global and emotional (β: −0.49; 95% CI: −0.94 to −0.05), was observed in patients with a GRRFI compared with those with a PRRFI (Table 2).

3.3. Cardiovascular Parameter Changes between RRFI Status and Different Time Points on Risk Factors and Medication Intake

There was no difference in clinical risk factors between patients with a GRRFI and a PRRFI in an unadjusted multivariable model (Table 3). Nevertheless, a multivariable adjusted model revealed a significant association between the BMI (β: 0.41; 95% CI: 0.07 to 0.75) and GRRFI, which increases when BMI does, meaning that there is a significant interaction between body weight and GRRFI (Table 3).

Medication intake, especially for beta-blockers, was significantly associated with GRRFI compared with PRRFI, by two-fold; however, the association changed in the multivariable adjusted model (Table 4).

Table 3. Changes in Clinical Parameters Compared with the Status of Physician Risk Factor Information Recollection in Chronic Coronary Syndrome Patients.

Dependent Variables	Physician Risk Factor Information Recollection						Difference in Change from Regression (Crude Model)	*p*-Value	Difference in Change from Regression (Adjusted Model)	*p*-Value [a]
	Poor Recollection (*n* = 445)			Good Recollection (*n* = 501)						
Clinical Parameters	Baseline	Interview	Mean Change in Baseline to Interview	Baseline	Interview	Mean Change in Baseline to Interview				
BMI, kg/m^2	27.58 ± 3.99	27.73 ± 3.97	0.15 ± 2.23	30.95 ± 4.25	31.12 ± 4.30	0.16 ± 2.23	0.01 (−0.30 to 0.33)	0.923	0.47 (0.11 to 0.83)	0.010
SBP, mm Hg	135.37 ± 19.87	132.29 ± 19.12	−3.08 ± 22.18	139.98 ± 21.75	134.64 ± 18.32	−5.34 ± 24.37	−2.25 (−5.32 to 0.81)	0.150	−2.50 (−5.99 to 0.98)	0.159
DBP, mm Hg	79.44 ± 10.64	79.13 ± 10.28	−0.31± 12.13	81.71 ± 12.31	80.77 ± 10.92	−0.94 ± 14.38	−0.63 (−2.39 to 1.12)	0.478	−0.13 (−2.11 to 1.85)	0.896
LDL-C, mmol	2.69 ± 1.11	2.20 ± 0.91	−0.49 ± 1.12	2.66 ± 1.16	2.24 ± 1.01	−0.42 ± 1.20	0.06 (−0.10 to 0.23)	0.427	−0.05 (−0.24 to 0.13)	0.588
HDL-C, mmol/L	1.26 ± 0.44	1.34 ± 0.38	0.08 ± 0.36	1.16 ± 0.39	1.27 ± 0.36	0.10 ± 0.33	0.02 (−0.02 to 0.07)	0.369	0.01 (−0.04 to 0.07)	0.577
Triglycerides, mmol/L	1.42 ± 0.90	1.38 ± 0.85	−0.03 ± 0.76	1.62 ± 0.96	1.54 ± 0.84	−0.08 ± 0.96	−0.05 (−0.17 to 0.07)	0.418	−0.05 (−0.19 to 0.08)	0.455

Continuous data are presented as means (SD). [a]: *p*-value derived from the differences between recollection of lifestyle advice and measurement time points. β coefficient for continuous outcomes. Model 1: crude model. Model 2: adjusted for age at the index event (continuous), gender, the index event, diabetes, and obesity.

Table 4. Change in Medication Intake Compared with the Status of a Physician's Risk Factor Information Recollection in Chronic Coronary Syndrome Patients.

Dependent Variables	Physician Risk Factor Information Recollection						Estimate of Difference in Change From Regression Model 1	*p*-Value	Estimate of Difference in Change from Regression Model 2	*p*-Value [a]
	Poor Recollection (*n* = 445)			Good Recollection (*n* = 501)						
Medication	Baseline	Interview	Percentage Change in Baseline to Interview	Baseline	Interview	Percentage Change in Baseline to Interview				
Antiplatelets	441 (99.1)	413 (93.7)	−5.4 %	493 (98.4)	463 (93.9)	% 5.6	1.04 (0.61–1.78)	0.867	1.05 (0.57–1.92)	0.87
Beta-blockers	406 (91.2)	369 (90.9)	−0.3%	461 (92.2)	441 (95.7)	1.9%	2.21 (1.26–3.87)	0.006	1.54 (0.81–2.91)	0.182
ACE inhibitors	358 (80.4)	289 (80.7)	0.3%	364 (72.7)	313 (86.0)	2.1%	1.46 (0.98–2.17)	0.058	1.47 (0.94–2.30)	0.091
Statins	420 (94.4)	380 (90.5)	−3.9%	474 (94.6)	434 (91.6)	0.4%	1.14 (0.72–1.80)	0.571	1.07 (0.63–1.80)	0.795

Categorical data are presented as numbers (percentages). [a]: odds ratio for categorical outcomes. Model 1: crude model. Model 2: adjusted for age at the index event (continuous), gender, the index event, diabetes, and obesity.

3.4. Recollection of Risk Factor Information and Lifestyle Changes

Overall, GRRFI was associated with lifestyle improvements compared with PRRFI in terms of reduction in salt intake (OR: 1.39; 95% CI: 1.02–1.90), reduction in fat intake (OR: 1.90; 95% CI: 1.31–2.76), reduction in sugar intake (OR: 1.63; 95% CI: 1.19–2.24), increase in fruit and vegetable intake (OR: 1.55; 95% CI: 1.11–2.15), increase in fish intake (OR: 1.37; 95% CI: 1.02–1.84), excess alcohol intake (OR: 1.76; 95% CI: 1.34–2.29), actively trying to lose weight (OR: 1.40; 95% CI: 1.02–1.91), actively trying to keep from gaining weight (OR: 1.58; 95% CI: 1.16–2.15), following dietary recommendations (OR: 1.39; 95% CI: 1.03–1.87), and following a special diet to lower blood pressure (OR: 5.87; 95% CI: 3.27–10.54) (Figures 1 and 2).

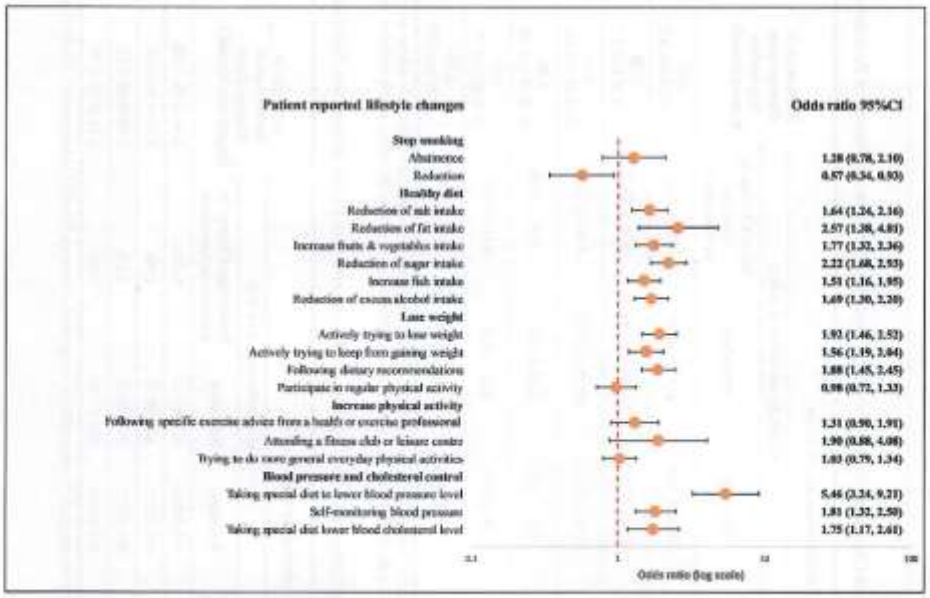

Figure 1. Univariable logistics regression analysis between the recollection of risk factors and patients' reported lifestyle changes. The model included the recollection of risk factor information (PRRFI = 0 and GRRFI = 1) as the independent variable and patients' reported lifestyle changes (no = 0 and yes = 1) as the dependent variables. PRRFI: poor recollection of risk factor information; GRRFI: good recollection of risk factor information.

In a subgroup analysis of the differences between age, gender, and GRRFI, there was no significant interaction observed between younger and older patients in terms of any lifestyle behavior changes in a univariable crude model (Figure 3) or a multivariable adjusted model (Figure 4).

On the other hand, we observed a significant interaction between diet characteristics, especially a reduction in fat intake ($p = 0.019$), and gender in a univariable crude model (Figure 5). In a multivariable adjusted model, this interaction remained unchanged ($p = 0.018$) (Figure 6).

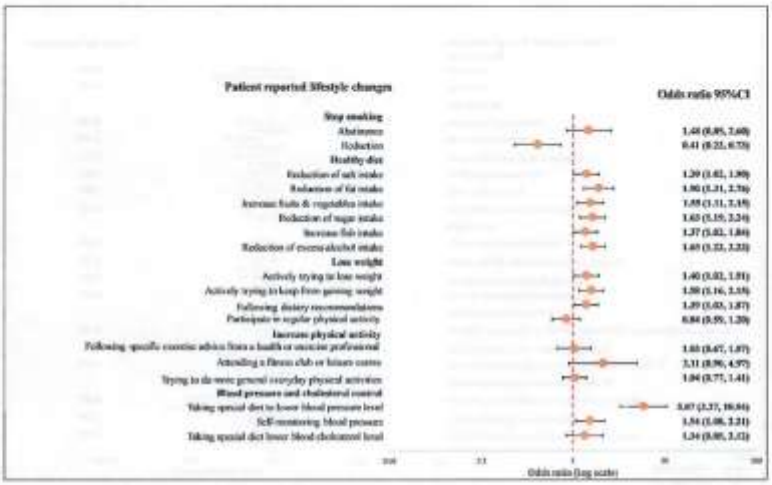

Figure 2. Multivariable logistics regression analysis between the recollection of risk factors and patients' reported lifestyle changes. The model included the recollection of risk factor information (PRRFI = 0 and GRRFI = 1) as the independent variable, patients' reported lifestyle changes (no = 0 and yes = 1) as the dependent variables, and age at the index event (continuous), gender, the index event, and obesity, as well as diabetes at hospitalization, as the covariates. PRRFI: poor recollection of risk factor information; GRRFI: good recollection of risk factor information.

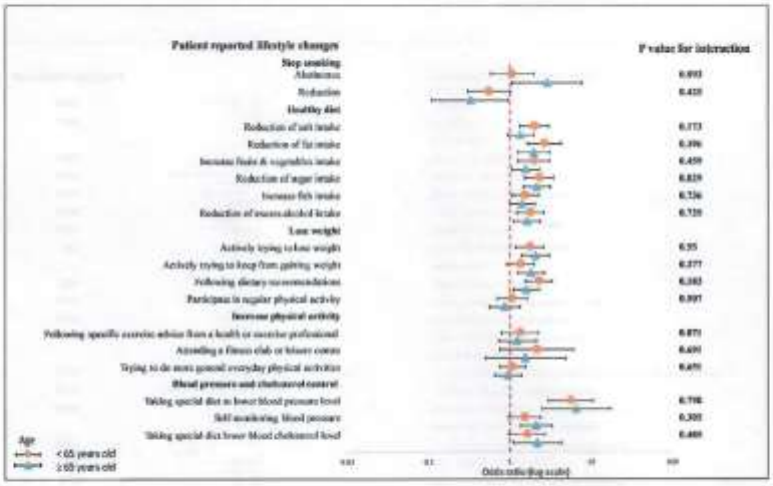

Figure 3. Univariable logistics regression analysis between the recollection of risk factors and patients' reported lifestyle changes in younger and older patients. The *p*-value corresponds to the interaction between younger and older patients. The model included the recollection of risk factor information (PRRFI = 0 and GRRFI = 1) as the independent variable and patients' reported lifestyle changes (no = 0 and yes = 1) as the dependent variables. PRRFI: poor recollection of risk factor information; GRRFI: good recollection of risk factor information.

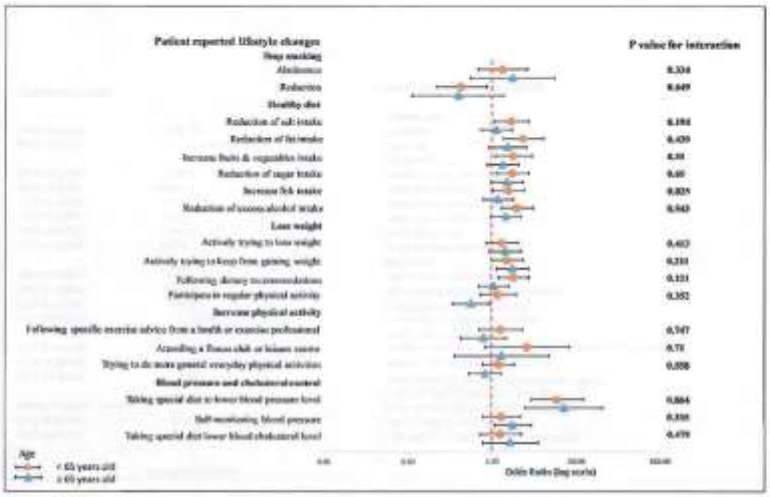

Figure 4. Multivariable logistics regression analysis between the recollection of risk factors and patients' reported lifestyle changes. The *p*-value corresponds to the interaction between younger and older patients. The model included the recollection of risk factor information (PRRFI = 0 and GRRFI = 1) as the independent variable, patients' reported lifestyle changes (no = 0 and yes = 1) as the dependent variables, and gender, the index event, and obesity, as well as diabetes at hospitalization, as covariates. PRRFI: poor recollection of risk factor information; GRRFI: good recollection of risk factor information.

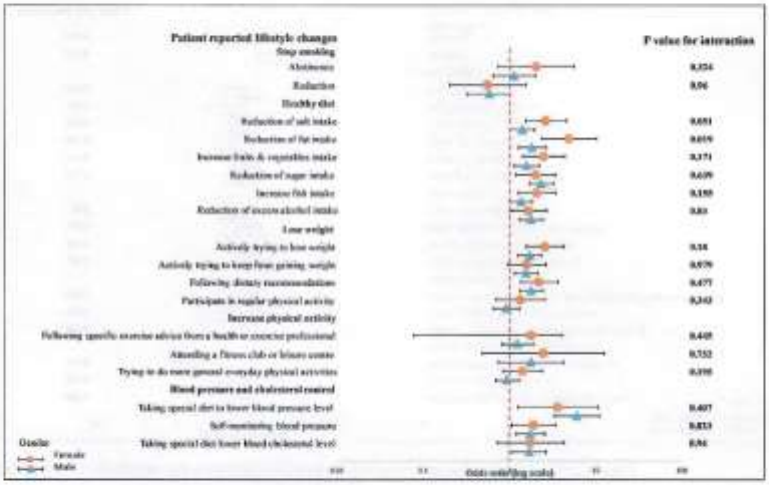

Figure 5. Univariable logistics regression analysis between the recollection of risk factors and patients' reported lifestyle changes in female and male patients. The *p*-value corresponds to the interaction between female and male patients. The model included the recollection of risk factors (PRRFI = 0 and GRRFI = 1) as the independent variable and patients' reported lifestyle changes (no = 1 and yes = 1) as the dependent variables. PRRFI: poor recollection of risk factor information; GRRFI: good recollection of risk factor information.

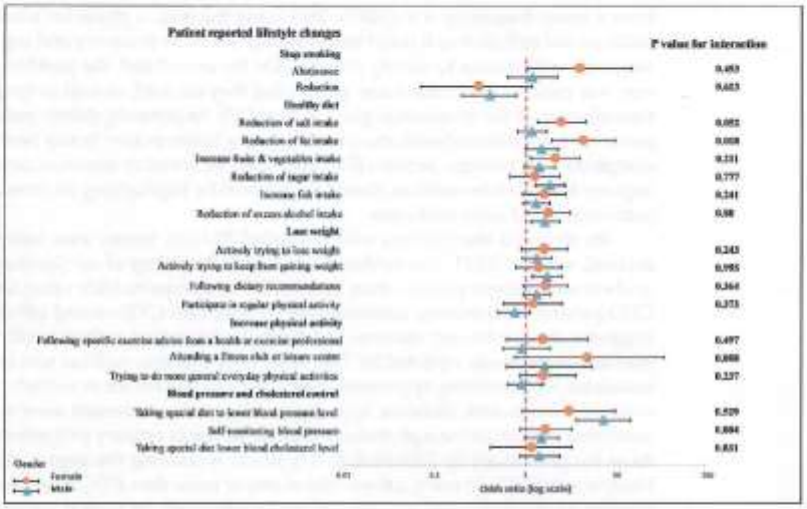

Figure 6. Multivariable logistics regression analysis between the recollection of risk factors and patients' reported lifestyle changes. The *p*-value corresponds to the interaction between female and male patients. The model included the recollection of risk factors (PRRFI = 0 and GRRFI = 1) as the independent variable, patients' reported lifestyle changes (no = 0 and yes = 1) as the dependent variables, and age at the index event (continous), the index event, and obesity, as well as diabetes at hospitilization, as the covariates. PRRFI: poor recollection of risk factor information; GRRFI: good recollection of risk factor information.

4. Discussion

The recollection of information on risk factors in the secondary prevention patients can still be improved. The recollection of lifestyle advice was the lowest in the oldest group and the highest in the middle-aged patients. Being obese or having diabetes was independently associated with a good recollection of a physician's information on risk factors. Patients with a GRRFI had worse risk factor control compared to those with a PRRFI. Despite better treatment adherence to antihypertensive drugs being observed in patients with a GRRFI, there was no significant improvement in the quality of life in heart QoL global, physical, and emotional compared with those with a PRRFI, but this may be due to the short observation time. The recollection of lifestyle advice demonstrated no difference in CVD risk factors between hospitalization and the time of the interview. While lifestyle behavior changed significantly with GRRFI between hospitalization and the time of the interview, there was no significant interaction in the age subgroups, but the pattern of fat intake was significantly different between females and males.

The recommendations for coronary heart disease management [16,20] include encouraging physicians and patients to be involved in clinical decision-making on suitable interventions, hence making lifestyle changes more effective. Sometimes, physicians could be less inclined to refer the elderly for an official recommended target intervention (e.g., a cardiac rehabilitation program) [21] due to the reason of frailty and other logistical problems in commuting to a hospital; hence, home-based lifestyle changes would be the best secondary preventive approach. A recent meta-analysis included 22 studies that assessed the association between lifestyle indices and CVD risk factors and revealed that the adoption of several healthy lifestyle behaviors showed a 66% reduction in CVD risks compared to the adoption of at least one or no healthy lifestyle behaviors [22]. This study showed that physicians were more likely to offer lifestyle interventions to older adults, which yielded the most favorable CVD outcomes. However, our results revealed that elderly patients

have a lower frequency of a GRRFI. This being the case, a physician's knowledge and skills are not sufficient as it could be a challenge for them to convey and explain all of the necessary information to elderly patients. On the other hand, the problem could be the way that patients understand and grasp what they are told, as well as the possibility of remembering all the information given to them [23]. Importantly, elderly patients are more prone to be in a state of denial about healthy eating habits or how to stay healthy in general compared with younger patients [24]. Therefore, an action or communication on how to improve lifestyle interventions should be followed by highlighting its necessity to elderly patients to avoid some confusion.

We observed that patients with multiple CVD risk factors were independently associated with a GRRFI. The evidence of a higher frequency of recollecting information in obese and diabetic patients than their PRRFI counterparts adds value, indicating that CHD patients with existing comorbidities overestimate CVD-related adverse outcomes, triggering them to be very cautious and disciplined in regard to their health condition. In contrast, in the study reported by Tiffe et al., only diabetes mellitus was independently associated with receiving appropriate physician lifestyle advice in secondary prevention, whereas patients with diabetes, hyperlipidemia, and hypertension were independently associated with receiving a physician's lifestyle advice in primary prevention settings [17]. As in the prior study by Tiffe et al. [17] typically measuring the impact of a physician's lifestyle advice (PLA) using a threshold of less or more than 50%, it remained unknown whether the threshold used was appropriate for secondary prevention settings as the study conducted compared PLA between primary and secondary settings. Importantly, our data suggest that patients in a secondary preventive setting with multiple comorbidities are more likely to recollect much clinical information, suggesting that patients' satisfaction in patient–doctor interactions provides great awareness of their disease conditions and associated risks. It should be kept in mind that observational studies often suffer from confounding factors or unmeasured factors; therefore, in terms of the statistical aspect, we present results from a step-wise multivariable adjusted model and a backward multivariable adjusted model to provide more intuitive evidence to report factors associated with the recollection of risk factor information.

A further noteworthy finding from our study was that patients with a GRRFI are nearly two-fold more likely to adhere to medication, and antihypertensive drugs in particular had a statistically significant effect on most of their lifestyle changes in the adjusted multivariable model (Figure 2). However, there were no significant age and gender differences in lifestyle changes and risk factor awareness, except for the fact that fewer men reduced their fat intake since being discharged from hospital than women. Generally, women are less likely to take medication than men, especially statin treatments [25,26], due to the possible side effects of drugs [27,28]. Moreover, based on our results, they were also less focused on lifestyle interventions in the area of limiting fat intake. Despite the fact that studies in "real world" populations have demonstrated that adherence to medical advice has a positive impact on CVD outcomes, with subsequently reduced rates of recurrent events [29–31], we observed that there were no changes in blood pressure, blood lipids, or body weight, and most of the patients did not achieve their secondary prevention goals. Our findings are in line with a recent report from the European Society of Cardiology, the EUROASPIRE IV survey 12, and even with their latest one, with a larger sample size from 81 regions in 27 European countries, the EUROASPIRE V registry [13], which reported that the majority of coronary patients did not achieve their risk factor goals in terms of blood pressure, low-density lipoprotein, cholesterol, and glucose targets.

Our report, based on the Polish population together with the results of multiple editions of the EUROASPIRE studies, highly encourages the implementation of new guidelines for CVD prevention in clinical practice in Europe. Specifically, in Poland, a managed-care program was introduced after the POLASPIRE study, and it was appreciated for its initiation. This approach could give a glimpse to cardiology physicians to assess the effect of the program by considering the POLASPIRE study as a control group and those reg-

istered in the managed-care program study as an intervention group. Changes in risk factor parameters (e.g., weight, blood pressure and lipid profile, smoking, and exercise) between these groups could provide some insights for improving the secondary preventive strategies. On the other hand, in terms of behavioral changes and also to motivate patients to change their lifestyles, comprehensive risk communication is very important. Taken together with the above discussion, it is important to explore the risk communication topic deliberately to facilitate the implementation of new recommendations and guidelines to improve secondary preventive strategies in chronic coronary syndrome patients.

This study possesses several limitations. First, the data on lifestyle recommendations from physicians were based on self-reporting; hence, recall bias was inevitable. Second, there is a higher possibility that patients who underwent a less-invasive procedure during hospitalization and have survived long enough after the index event would be able to undergo clinical examinations and interviews, so we do not have complete data from more-severe patients. Therefore, our results might overemphasize the level of GRRFI or PRRFI. However, with the strong threshold of GRRFI $\geq$ 80% applied in our study, compared with the threshold provided in other study, which is PLA (a physician's lifestyle advice) $\geq$50% [17], we believe that the above-mentioned unmeasured confounding factors were controlled in the study. Our study was conducted in the Polish population, and, thus, our results and clinical implications may not be generalizable to other European populations or regions due to different risk profiles, age compositions of disease, and distributions of lifestyle factors. Hence, our study should be interpreted with caution, and further research is required to overcome these limitations. Finally, the multivariable model included only the known CVD risk factors collected in the study; we were unable to control for unmeasured confounding, thus leaving room for residual confounding.

The novelty of the presented study relies on the multiparameter approach to the patient–doctor communication process. It has to be emphasized that there is no successful "one type fits all" strategy, and, each time communication is performed, in order to be effective, it must include a recipient's characteristics, as well as an approach towards one's health, health literacy, and trust in healthcare. These factors have been strikingly important in the recent efforts to increase vaccination frequency during the COVID-19 pandemic [32]. Moreover, we point out that the patients with the poorest recollection of information are the oldest (which could be expected), but they are also the patients with fewer comorbidities, who also deserve attention and ways to receive appropriate health information. Elderly patients, often excluded from modern sources of information, such as the Internet, require particular visual aids to improve their awareness of risk factors, as well as the involvement of their closest family members or caretakers.

5. Conclusions

This study revealed that the prevalence of a patient's recollection of risk factor information was higher in patients with multiple comorbidities and that these patients significantly change their lifestyle behaviors. This suggests that physicians are focused on informing patients with multiple comorbidities. A secondary prevention setting should include modern preventive cardiology programs with multidisciplinary teams of healthcare professionals to address all aspects of lifestyle and risk factor management, hence reducing the risk of adverse cardiovascular events. Following this, country-specific coronary heart disease managed-care programs should be implemented based on the needs of particular subpopulations.

Recommendations

The knowledge from our study provides several clinical implications. Our investigation on the determinants of the recollection of risk factor information in chronic coronary syndrome patients revealed that slightly more than half of the patients, especially those with multiple comorbidities, recollected risk factor information at a high threshold, about $\geq$80%. This indicates that physicians were more concerned with patients with multiple

risk factors. Therefore, it is important to leverage an approach with innovative ways to help convey information and ensure the long-term effectiveness of communication. Our findings have implications for understanding the effectiveness of patient–doctor interactions and patients' compliance with a physician's information. Notably, communication skills are crucial to successful medical practice, which greatly impacts patients' satisfaction, compliance, and outcomes. Importantly, a modern secondary prevention program should be designed and include effective communication strategies, hence encouraging vigorous behavioral changes.

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Institutional Review Board Statement: This study was conducted according to the guidelines of the Declaration of Helsinki and was approved by the Ethics Committee of the Medical University of Bialystok (R-I-002/323/2016).

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: Data available on request only for scientific purposes.

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Conflicts of Interest: The authors declare no conflict of interest.

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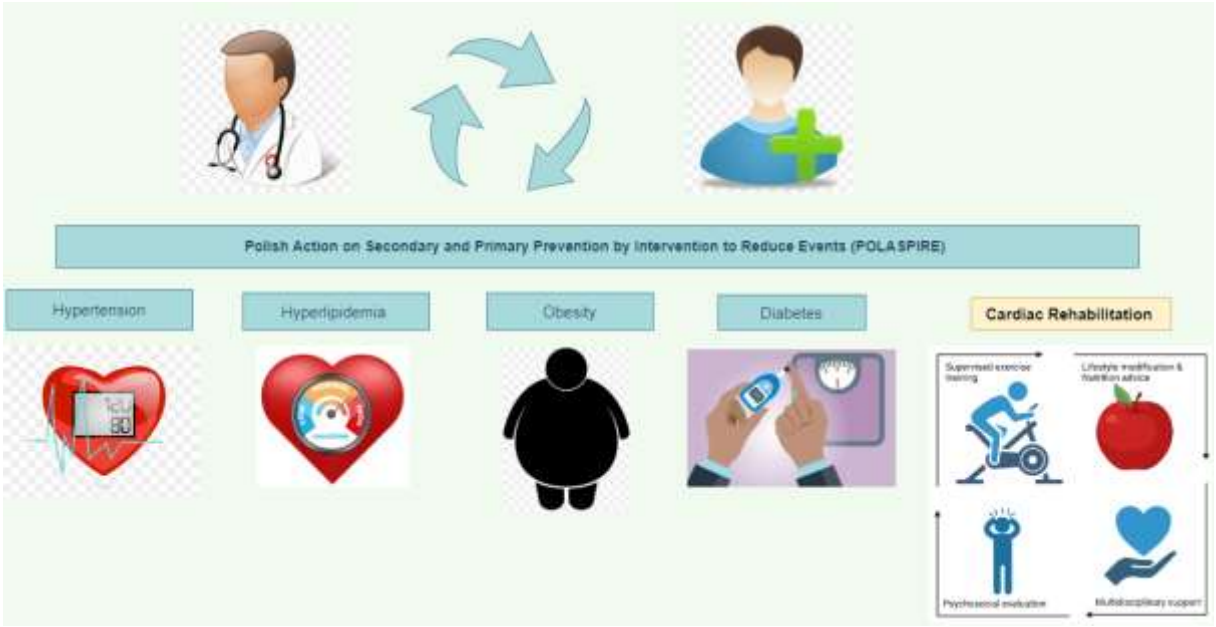
8. Summary

8.1 Summary (Polish)

Wskaźniki strategii prewencji wtórnej pozostają niskie w Europie, a także w Polsce. Rehabilitacja kardiologiczna (CR) poprawia wyniki przeżycia u pacjentów z chorobą niedokrwienną serca (IHD), jednak długoterminowe korzyści z krótkoterminowych programów są nadal przedmiotem dyskusji. W kraju, w którym możliwości kierowania na CR są ograniczone, uważamy iż udział w stacjonarnej CR powinien być skoordynowany z całą długoterminową strategią działań prewencyjnych. W przewlekłym zespole wieńcowym (CCS) zasadnicze znaczenie ma przestrzeganie przez pacjenta zaleceń lekarza dotyczących stylu życia. Ocena cech związanych z przypominaniem sobie przez pacjenta informacji od lekarza i zmian stylu życia może wyjaśnić znaczenie indywidualnego dostosowania interwencji prewencyjnych.



Rycina 1. Zintegrowane podejście do postępowania z czynnikami ryzyka u pacjentów z przewlekłym zespołem wieńcowym. Interakcja między pacjentem a lekarzem jest podstawowym czynnikiem wpływającym na lepsze przestrzeganie zaleceń dotyczących kontroli czynników ryzyka CVD. Program rehabilitacji kardiologicznej powinien być włączony i omówiony podczas konsultacji pacjenta z lekarzem w celu ustalenia strategii prewencyjnych.

8.2 Summary (English)

Secondary prevention strategies rates remain poor in Europe as well in Poland. Cardiac rehabilitation (CR) improves survival outcomes in patients with ischemic heart disease (IHD), however the long term benefits of short-term programs are still discussed. While, in the country where the capacity for stationary CR referral is low , we consider it of high importance to combine with various long term actionable preventive strategies. A patient's compliance to a physician's lifestyle information is essential in chronic coronary syndrome (CCS). Assessing the characteristics associated with a patient's recollection of physician information and lifestyle changes could elucidate the importance of individual tailoring of preventive interventions.

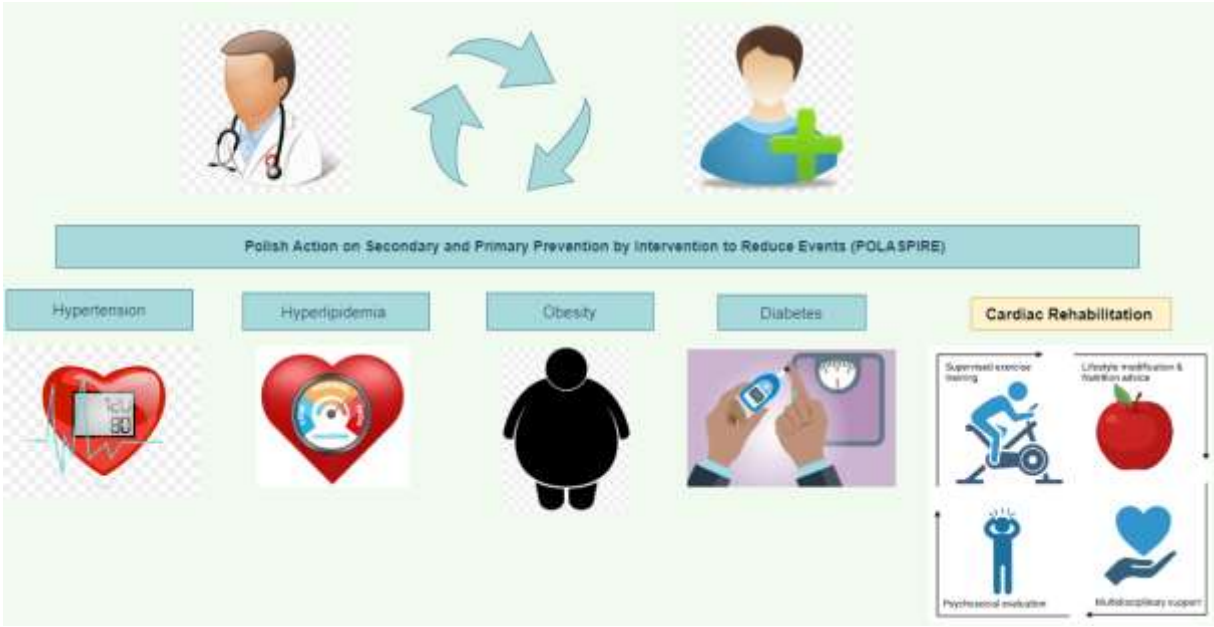


Figure 2. Integrated approach for risk factor management in chronic coronary syndrome patients. Interaction between patient and physician is a fundamental approach for better adherence for CVD risk factor control. Cardiac rehabilitation program should be integrated and discussed during patient-physician consultation when deciding preventive strategies.

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3. https://www.who.int/europe/news/item/18-01-2021-new-who-report-population-based-screening-for-cardiovascular-disease-risk-factors-does-not-reduce-cvd-mortality

10. Declaration of the author of the doctoral dissertation

Appendix 1 to the Anti-plagiarism Regulations

DECLARATION

I hereby declare that my work entitled
Integrated approach to cardiovascular risk factor management in patient with chronic coronary syndrome.
has been created under the substantive supervision of the supervisor prof.dr hab.Karol Kaminski

a. was prepared by me myself,*
b. does not infringe copyright within the meaning of the act of 4 February 1994 on copyright and related rights (*i.e. Journal of Laws of 2019 item 1231)* and personal property protected by law,
c. does not contain data and information that I obtained illegally,
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* Taking into account the substantive contribution of the supervisor
**- delete as appropriate

11. Information about nature of participation and author's contribution and statements from co-authors

Effects of cardiac rehabilitation on risk factor management and quality of life in patients with ischemic heart disease: a multicentre cross-sectional study. authors: Siamala Sinnadurai, Pawel Sowa, Piotr Jankowski, Zbigniew Gasior, Dariusz A.Kosior, published in *Polish Archive of Internal Medicine*, 2021; 131(7-8): 617-625

Author's name and surmane	Nature of participation	Contribution in %
PD student – Siamala Sinnadurai	Conception and design, article preparation, biostatistics analysis, interpretation of the data and manuscript preparation	60%
Dr.Pawel Sowa	Supervision, final review	7%
Professor Piotr Jankowski	Supervision, revising the review	2%
Professor Zbigniew Gasior	Final review	1%
Professor Dariusz A.Kosior	Final review	1%
Professor Maciej Haberka	Final review	1%
Professor Danuta Czarnecka	Final review	1%
Professor Andrzej Pajak	Supervision, revising the review	2%
Dr Malgorzata Setny	Final review	2%
Dr. Jacek Jamiolkowski	Final review	2%
Magda Lapinska	Final review	1%
Professor Karol Kaminski	Conception, design, analysis, supervision, revising and review	20%

Recollection of Physician Information about Risk Factor and Lifestyle Changes in Chronic Coronary Syndrome Patients. authors: Siamala Sinnadurai, Pawel Sowa, Piotr Jankowski, Zbigniew Gasior, Dariusz A.Kosior, published in *International Journal of Environmental Research and Public Health*, 2022; 19(11), 6416

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vii. Supervision
viii. Project administration

I agree to use this publication by Siamala Sinnadurai , in the procedure for awarding the doctoral degree in the field of medical sciences and health sciences in the discipline of medical sciences.

signature

12. Consent from the Bioethics Committee

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Białystok, 20-12-2018

R-I-002/323/2016

Sz.P.
Prof. dr hab. Karol Kamiński

Komisja Bioetyczna UMB na posiedzeniu w dniu 20.12.2018 r. zapoznała się z wnioskiem do tematu badawczego: „Poszukiwanie czynników ryzyka rozwoju oraz ocena częstości występowania przewlekłej niewydolności serca (ang. CHF) u osób po zawale serca leczonym angioplastyką wieńcową" i **wyraża zgodę** na włączenie do zespołu Rama Guggilla, Siamala Sinnadurai, lek. Natalii Jurczuk.

Z poważaniem,

Przewodnicząca Komisji Bioetycznej UMB

prof. dr hab. Otylia Kowal-Bielecka