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ORIGINAL RESEARCH

Are exercise prescriptions for patients with cardiovascular disease, made by physiotherapists, in agreement with European recommendations?

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Aims Physiotherapists often treat patients with (elevated risk for) cardiovascular disease (CVD), and should thus be able to provide evidence-based exercise advice to these patients. This study, therefore, aims to examine whether exercise prescriptions by physiotherapists to patients with CVD are in accordance with European recommendations.

Methods and results This prospective observational survey included forty-seven Belgian physiotherapists. The participants agreed to prescribe exercise intensity, frequency, session duration, program duration, and exercise type (endurance or strength training) for the same three patient cases. Exercise prescriptions were compared between physiotherapists and relations with their characteristics were studied. The agreement between physiotherapists' exercise prescriptions and those from European recommendations ('agreement score': based on a maximal score of 60/per case) was assessed. A wide inter-clinician variability was noticed for all exercise modalities, leading to a large variance for total peak-effort training minutes (from 461 up to 9000 over the three cases). The exercise frequency was prescribed fully out of range of the recommendations and the prescription of additional exercise modes was generally flawed. Exercise intensity and program duration were prescribed partially correct. The addition of strength exercises and session duration was prescribed correctly. This led to physiotherapist agreement scores of 25.3 ± 9.6, 23.2 ± 9.9, and 27.1 ± 10.6 (all out of 60), for cases one, two, and three, respectively. A greater agreement score was found in younger colleagues and those holding a Ph.D.

Conclusion Exercise prescriptions for CVD patients vary widely among physiotherapists and often disagree with European recommendations.

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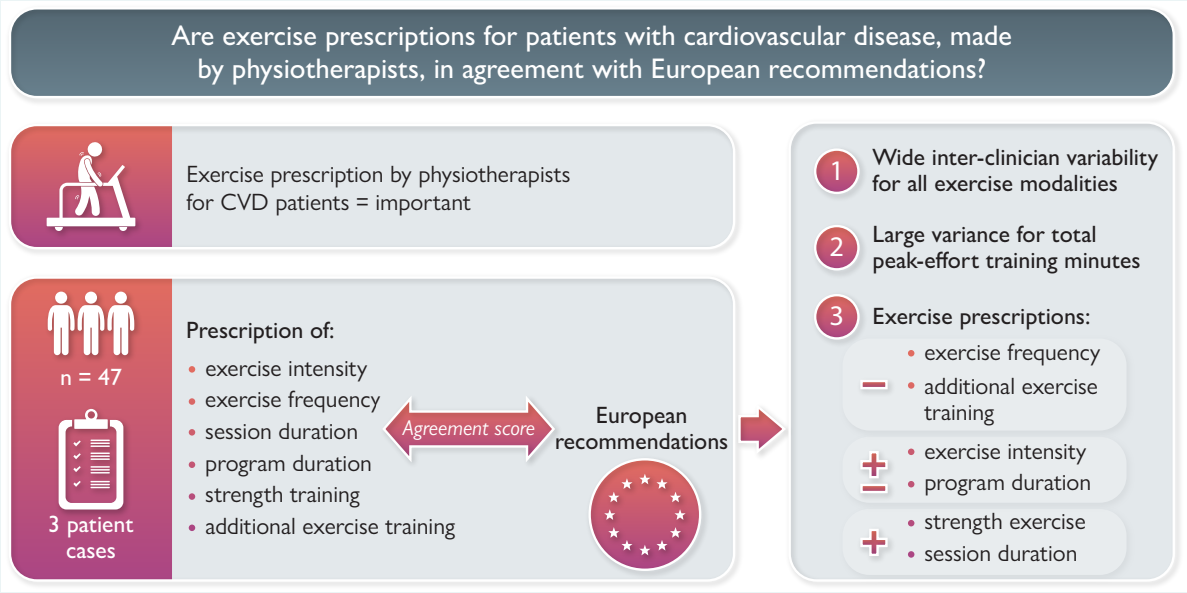
Graphical Abstract



Keywords Cardiovascular disease • Exercise prescription • Physiotherapy

Novelty

- Physiotherapists struggle with the correct prescription of exercise to patients with CVD.
- The level of agreement between exercise prescriptions from physiotherapists and the European recommendations for patients with CVD is very low.
- There is a need for standardisation efforts regarding integrated exercise prescription in cardiovascular rehabilitation.

Introduction

Exercise therapy, as part of a multidisciplinary approach, leads to significant improvements in exercise capacity, muscle strength and endurance, and quality of life in patients with established cardiovascular disease (CVD) or at high CV risk (e.g. obesity, hypertension, diabetes), thereby reducing CV event rates, hospitalizations, and mortality.[1,2] It is therefore a cornerstone in multidisciplinary management for CV health,[3] as stipulated in European recommendations.[3–5]

However, a recent European survey reported a worrisome inter-clinician variance in exercise prescription for the same CVD (risk) patient, at least among cardiologists.[6] Similar findings were noticed in primary care physicians from Italy.[7] Thus, the current exercise prescription in clinical practice is likely to be suboptimal for many patients with CVD (risk).

In clinical practice, however, physiotherapists are often confronted with patients with (elevated risk for) CVD, even though this is not always the primary indication for referral to the physiotherapist (e.g. a patient with tendinopathy who is also obese or suffers from diabetes or previous CVD). On the other hand, based on internationally recognized competencies, physiotherapists should be able to prescribe evidence-based exercise when requested by the patient.

However, it remains to be assessed whether physiotherapists would indeed prescribe/advise exercise to patients with CVD (risk) in accordance with European recommendations. It is also unknown whether physiotherapists' characteristics (e.g. age, sex, qualifications, years of experience, work setting, and location) are associated with the quality of these exercise prescriptions.

We hypothesised that a significant inter-physiotherapist variance, next to disagreement with current recommendations, would be present when prescribing exercise to patients with CVD risk factors or established disease. In contrast to previous studies, the novelty in this study is that we focus on physiotherapists that are considered to have more expertise with exercise prescription compared to medical doctors and that we now apply a computation method to calculate the level of agreement with the European recommendations.

Material and methods

We used the SQUIRE checklist when writing our report.[8]

Participants

The study was approved by the ethical committee from Hasselt University, Belgium (registration number: CME2020/056). Participants ($n = 47$) were recruited between February and April 2022 by mailing from AXXON (Belgian Physiotherapy Association) to their members, and by mailing to personal Flemish physiotherapy networks. After completing an online

consent form, explaining the nature and aim of this study, participants were able to enter the study. The study emphasised that participation was voluntary and that their relationship with AXXON was not affected by the decision to participate. Hasselt University provided all necessary documentation regarding email invitations, participant information sheets, consent forms, and privacy notices. Researchers did not have access to any personal details of potential participants.

In this study, only professionally active Flemish physiotherapists were recruited. There were no restrictions on years of experience or characteristics of the setting in which they were active. Participants were excluded from the study if they did not have access to a device that allows the use of the EXercise Prescription in Everyday practice & Rehabilitative Training (EXPERT) tool (explained below).[9,10] All participants came from Flanders, which is the northern (Dutch-speaking) part of Belgium.

EXPERT tool

The study was conducted online using the EXPERT tool, provided by Hasselt University, Belgium. The EXPERT tool is a training and decision support system, designed and built by computer scientists from Hasselt University, in close collaboration with the European Association of Preventive Cardiology (EAPC) EXPERT Network group. It automatically generates a (personalised) exercise prescription according to the characteristics of each patient case, thus integrating the exercise prescriptions for different CVDs and risk factors within the same patient. In the EXPERT tool, exercise training recommendations and safety precautions are available for ten CVDs, five CVD risk factors, and three common chronic non-CV conditions. The EXPERT tool also considers the baseline exercise tolerance, common CV medications, and occurrence of adverse events during exercise testing.[9,10] The exercise prescriptions of the EXPERT tool are based on European recommendations,[3,11–13] evidence, and expert opinions, collected by a working group of 33 CV rehabilitation specialists from 11 European countries.[9,10] This tool was used to generate exercise prescriptions for the three patient cases that were the subject of the present study. Hence, the exercise prescriptions generated by the EXPERT tool are prescriptions fully based on the most recent European recommendations (EAPC and ESC).

Measurements

Participants first completed a baseline assessment and then got access to the EXPERT tool for patient case fill-out.

Assessment

The assessment consisted of an initial questionnaire (See Addenda for Supplementary material online, *Table S1*) including:

- Demographics; age, sex, qualifications, setting in which they worked (private practice with or without focus on rehabilitation of internal disorders, hospital-based cardiovascular rehabilitation (CR) program (e.g. individual or group based, gym or circuit sessions), and years of experience.
- Perceived awareness of, and adherence to, CR existing exercise prescription guidelines, barriers and facilitators to implementation, and resources/ability to support to fully implement guideline-based rehabilitation.

After completing the baseline assessment (*Figure 1*), participants were given access to three patient cases with different complexity via the EXPERT tool. Each case increased in complexity by increasing the level of CVD risk and the presence of comorbidities. The participants had to specify their preferred exercise intensity [based on the percentage of peak heart rate (HR)], exercise frequency (days/week), program duration (weeks), exercise session duration (min/session), and whether strength training exercises had to be executed. Furthermore, participants were asked to indicate whether additional exercise training types had to be considered, e.g. handgrip strength training, inspiratory muscle training (IMT), callisthenics, balance exercises, etc. The participants did not receive feedback or a score on their fill-out of the baseline case studies. A detailed description of the patient cases can be found in *Table 1*.

Patient case score calculation

Based on the fill-out of the three patient cases, a score to assess the level of agreement with European guidelines was calculated ('agreement score'). A score of 0, 5, or 10 was assigned to exercise prescriptions for each modality separately (i.e. intensity, frequency, session duration, program duration, and the addition of strength training). Determination of the score per modality was done as follows:

- A score of 0 was assigned when the physiotherapists' prescriptions were fully out of the range prescribed by the EXPERT tool.
- A score of 5 was assigned when the clinicians' prescriptions were partially within the range prescribed by the EXPERT tool.
- A score of 10 was assigned when the physiotherapists' prescriptions were fully within the range prescribed by the EXPERT tool.

For the additional training prescriptions (e.g. IMT, balance training, etc.), a score of 0 was assigned when prescribing no additional training modes or additional training modes were not correct. A score of 5 or 10, respectively, was assigned when the prescribed exercise training was partially or fully in accordance with the EXPERT tool prescriptions.

So, for each case, a total agreement score of 60 could be achieved. Based on these sub-scores and total scores, comparisons were made between the physiotherapists' prescriptions and the EXPERT tool prescriptions.

Statistical analyses

Statistical analyses were executed using SPSS v.24.0 (SPSS Inc., Chicago, USA). Averages ± standard deviations and percentages were calculated and presented. For each case, total exercise volume (expressed as peak-effort training minutes) was calculated by: number of prescribed weeks (*n*) * number of prescribed sessions/week (*n*) * prescribed individual session duration (min) * prescribed exercise intensity (%HR_{peak}).

Figure 1 Study flow.

Table 1 Description of the exercise cases

	Case 1	Case 2	Case 3
Diagnosis	AMI with PCI	AMI with CABG	Myocardial ischemic threshold @ 90 bts/min
CV risk factors	Dyslipidemia Hypertension	Obesity Dyslipidemia Hypertension	Type 2 diabetes Hypertension
Non-cardiovascular comorbidities	—	COPD	Sarcopenia Frailty
Age (years)	71	76	71
Body weight (kg)	65	80	90
Body height (cm)	171	182	165
Sex (M/F)	M	M	F
VO2max (l/min)	2.5	1.5	0.767
HRrest (bpm)	55	52	52
HRmax (bpm)	123	112	100
Blood pressure (mm/Hg)	145/82	125/80	135/75
Fasting glycemia (mg/dL)	95	102	115
Total cholesterol (mg/dL)	180	189	234
Smoker	No	No	No
Medication intake	Beta Blocker Statin	Beta Blocker Statin	Beta Blocker Statin Insulin

AMI, acute myocardial infarction; Bpm, beats per minute; CABG, coronary artery bypass grafting; cm, centimetre; COPD, chronic obstructive pulmonary disease; dl, decilitre; F, female; kg, kilogram; l, litre; M, male; mg, milligram; mm, millimetre; min, minute.

One-way ANOVA was performed to examine relations between baseline characteristics (age, sex, qualifications, special competence, experience, setting) and clinicians' prescriptions. The statistical significance was set at $P < 0.05$ (2-tailed).

Results

Baseline characteristics

Forty-seven physiotherapists gave consent and participated in this study. The majority of them were female (71%). There were no restrictions in qualification (29% Bachelor of Science, 56% Master of Science) or characteristics of the setting (52% hospital-based) in which they were active. None of the participants had any experience with using the EXPERT tool at the time of patient case fill-out (see *Table 1*).

Application of cardiovascular rehabilitation exercise guidelines

Less than half of the participants (43%) indicated using the CR exercise recommendations of the EAPC. Thirty percent used the recommendations of 'Koninklijk Nederlands Genootschap voor Fysiotherapie' (KNGF), which is the Dutch association for physiotherapy. Finally, 18% of the participants used a combination of both guidelines. Almost 10% of the participants used other or no guidelines when prescribing exercise to CVD (risk) patients (see *Table 2*). The majority of the participants stated having a positive attitude towards the application of CR guidelines (understanding and application, infrastructure, barriers). Moreover, they acknowledged the state-of-the-art design of these guidelines. However, there was a more variable (and even negative) attitude towards guideline updates. In the majority of the participants, the delivery of exercise prescriptions was not affected by the work facilities (see *Table 3*).

Exercise prescriptions by physiotherapists vs. EXPERT tool

Case 1

Exercise frequency, as well the prescription of additional training, were prescribed fully wrong by 77% and 81%, respectively, of the physiotherapists. However, session duration (by 92%), as well as the prescription of strength training (by 87%), were prescribed correctly. Exercise intensity was scored variable from correct (30%) to partially correct (28%) or fully wrong (41%). Also, the program duration was scored variable (prescribed fully wrong by 36% but correctly by 62%). The overall agreement score for this case was 25.3 ± 9.6 out of 60 (see *Tables 4 and 5; Figure 2*).

Case 2

Exercise frequency (77%), exercise intensity (55%) as well program duration (74%) were prescribed fully wrong by most of the physiotherapists. Moreover, also the prescription of additional training modes was fully wrong (48%) or partially wrong (48%). However, session duration (by 86%), as well as the prescription of strength training (by 91%), were prescribed correctly. The overall agreement score for this case was 23.2 ± 9.9 out of 60 (see *Tables 4 and 5*).

Case 3

Exercise frequency (75%) as well the program duration (67%) were prescribed fully wrong by most of the physiotherapists. Moreover, also the prescription of additional training modes was fully wrong (57%) or partially wrong (43%). However, session duration (by 77%), exercise intensity (by 91%) as well as the prescription of strength training (by 93%) were prescribed correctly. The overall agreement score for this case was 27.1 ± 10.6 out of 60 (see *Tables 4 and 5*).

In general, a wide range of inter-clinician variability was noticed in the exercise prescriptions (see *Figure 1*).

Associations between physiotherapists' characteristics and exercise prescriptions

Longer programs were prescribed by female ($P < 0.001$) and younger physiotherapists (30–39 years, $P = 0.022$; compared to physiotherapists aged 40–49 years), holding a Ph.D. [compared to licentiates ($P = 0.001$) and Master degrees ($P = 0.020$)], working in a hospital setting ($P = 0.012$; compared to clinicians working in private practice) or having special competence in cardiovascular physiotherapy ($P = 0.015$). Longer exercise sessions were prescribed by physiotherapists having special competence in cardiovascular physiotherapy ($P = 0.008$), working in a hospital setting ($P = 0.019$) or in a combination of two settings ($P = 0.045$; compared to working in private practice) or by clinicians claiming to adopt the EAPC guidelines ($P = 0.046$; compared to clinicians who do not claim to adopt any guideline).

A significantly higher total agreement score was obtained by younger (30–39 years) vs. older physiotherapists (40–49 years) ($P = 0.026$) and by physiotherapists holding a Ph.D. vs. licentiate degree ($P = 0.024$).

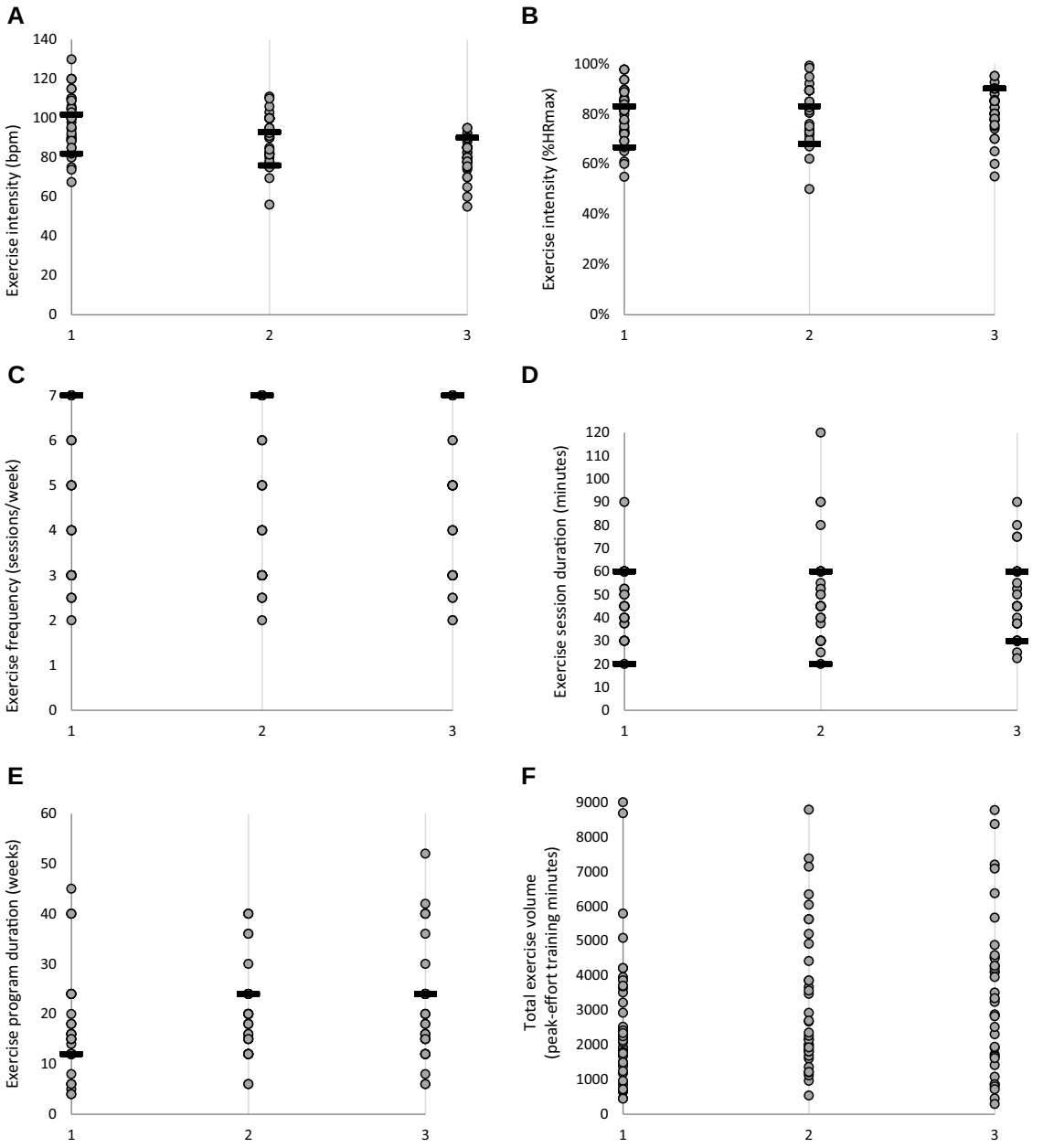


Figure 2 Clinicians' prescriptions (grey dots) vs. EXPERT recommendations (black lines) for exercise intensity (*A* and *B*), exercise frequency (*C*), exercise session duration (*D*), exercise program duration (*E*), and total exercise volume (*F*) per case (see horizontal axis).

Discussion

This study showed that exercise prescriptions to patients with CVD, generated by physiotherapists, varied widely among themselves, and the level of agreement with European recommendations for specific exercise modalities was low.

In general, wide inter-physiotherapist variability was noticed for exercise prescription to patients with CVD, and this applied to virtually all exercise modalities (e.g. intensity, frequency, session and program duration, the total volume of exercise). Hereby, we have to acknowledge the wide range in the current exercise recommendations which mainly allows the physiotherapist to provide progression during the exercise program according to the progression of the patient and based on his own clinical competence.

However, when a patient with established CVD would consult different physiotherapists, very different exercise prescriptions could emerge. This is well illustrated by the total peak-effort training minutes, which varied from 461 up to 9000 over the three patient cases. This would predict very different clinical outcomes, as the total volume of exercise is a key driver to significant improvements in various health indicators (e.g. physical fitness, fat mass, lipid profile).[14,15] The observed variance in exercise prescription could be hypothesised to be related to different habits in exercise prescription, knowledge of clinical guidelines, education, and/or

Table 2 Baseline characteristics of the participants ($n = 47$)

Sex (M/F)[a]	13/31 (29.5/70.5)
Age[a]	
<30 years	19 (42.2)
30–39 years	8 (17.8)
40–49 years	9 (20.0)
50–59 years	8 (17.8)
>60 years	1 (2.2)
Qualifications[a]	
Graduate/BSc Physiotherapy	13 (28.9)
Licentiate	4 (8.9)
MSc Physiotherapy	25 (55.6)
Ph.D.	3 (6.7)
Work setting[a]	
Hospital	23 (52.3)
Private practice	11 (25.0)
Hospital & private practice/hospital	9 (20.5)
Education	1 (2.3)
Number of years delivering cardiac rehabilitation?[a]	
<1 year	9 (20.9)
1–5 years	15 (34.9)
6–10 years	8 (18.6)
>10 years	11 (25.6)
Use of guidelines when prescribing exercise to patients with (elevated risk for) cardiometabolic disease[a]	
EAPC	19 (43.2)
KNGF	13 (29.5)
EAPC + KNGF	8 (18.2)
Other	3 (6.8)
None	1 (2.3)

Data are expressed as *n*(%).
BSc, Bachelor of Science; EAPC, European Association of Preventive Cardiology; F, female; KNGF, Koninklijk Nederlands Genootschap voor Fysiotherapie; M, male; MSc, Master of Science.
[a]Missing data for this parameter.

organisation of the rehabilitation units and private physiotherapy practices in Belgium.[16]

More specifically, the education of physiotherapists has undergone profound changes in Flanders in recent decades. Since the Decree on the reform of higher education in physiotherapy and rehabilitation sciences in the Flemish Community in 1998, the degree of a physiotherapist can only be obtained after a minimum study period of four years. This resulted in a particular situation where the colleges of higher education set up a four-year course and the universities a five-year course to obtain a licentiate in physiotherapy. With the implementation of the Bologna agreements in 2005, all the courses were integrated into the universities by a Bachelor's and Master's structure. The Master's program consists of a three-year Bachelor's program that does not give access to the profession, followed by a two-year Master's program. In the final year of this Master's program, students follow in-depth courses in one specific clinical population. Since 2015, after their five-year basic training, physiotherapists can also obtain a special professional competence in a specific field, recognized by the Flemish government. This indicates that the physiotherapist has far-reaching and in-depth clinical experience. This also applies to physiotherapy for CVD. Important in the context of this study is the fact that currently about 50% of the clinically active physiotherapists still consists of physiotherapy graduates who have had a three-year training.

In addition, some locally used [in this case, from the KNGF (Royal Dutch Physiotherapy Association)] guidelines on exercise training in CVD are (slightly) different from European guidelines,[17,18] which may also lead to variance in exercise prescriptions. Most importantly, these different exercise prescriptions may also originate from the lack of guidance on how to integrate different exercise prescriptions within the same patients with different CVDs and risk factors. It remains hard to prescribe exercise to a patient with different CVD risk factors, while for each risk factor different exercise modalities should be preferred. Next to these hypothesised causes, different exercise prescription routines may also be due to legal constraints (national regulations for reimbursement of rehabilitation sessions, which can affect program duration and the total number of exercise sessions and thus exercise frequency) as well as environmental constraints (limited infrastructure and centre/hospital facilities, which may affect the capability to implement strength training exercises or other exercise training types).

However, even in the European recommendations on exercise-based CV rehabilitation, a variability or range within exercise modalities is allowed (e.g. exercise at 60–75% of HR_{max}). Hence, it remained to be studied whether the observed variability among physiotherapists would lead to disagreement with current recommendations. This seemed however to be the case. In all cases, the exercise frequency was prescribed fully out of range of the recommendations (too low) and the prescription of additional exercise modes was generally flawed. However, it could be the case that the physiotherapists considered the exercise sessions as strictly office- or centre-based sessions, and did not take into account the home-based exercises they would prescribe/advise. In future studies, this may have to be explained more clearly to the participants in advance. The lack of prescription for additional exercises (e.g. IMT, balance training, etc.), however, does seem to be interesting to notice. The investigated physiotherapists very often did not consider exercise types beyond the traditional endurance and strength exercises, even though these additional exercises are of significant relevance to the patients (e.g. IMT after CABG surgery for re-establishing pulmonary function and exercise capacity,[19] the importance of a large caloric expenditure in case of dyslipidemia or obesity and the importance of isometric handgrip strength training for the management of hypertension[20]) The exercise intensity and program duration were prescribed partially correct. However, most often the addition of strength exercises and session duration was prescribed correctly by the physiotherapists. This led to physiotherapist scores of 25.3 ± 9.6, 23.2 ± 9.9, and 27.1 ± 10.6 out of 60, for cases 1, 2, and 3, respectively. These scores thus seem to be low.

Another important finding in this study was the discovery of significant associations between clinicians' prescriptions and their characteristics. It seems that having special competence in CR as well as working in a hospital setting leads to the prescription of longer exercise sessions and prolonged programs. This could be possibly explained by a greater awareness of these specialised physiotherapists for the need of CVD patients for extended exercise. Moreover, this awareness of greater exercise dose also seemed to be more present in younger, female, and higher educated clinicians (e.g. holding a Ph.D.), as well as in physiotherapists claiming to adhere better to the EAPC guidelines. Whether this would also automatically translate into a greater agreement with CR (EAPC) guidelines, was harder to establish. A significantly greater total agreement score (means better agreement with EAPC guidelines) was obtained by younger physiotherapists and those holding a Ph.D. It could be hypothesised that the younger physiotherapists received information from more recent European recommendations on how to prescribe exercise in their curriculum, or could be more actively

Table 3 Statements regarding the implementation of cardiovascular rehabilitation guidelines

	Totally agree	Agree	Slightly agree	Neither agree nor disagree	Slightly disagree	Disagree	Totally disagree	Don't know
I fully understand how to prescribe cardiovascular rehabilitation exercise in accordance with the current guidelines (including for those with different combinations of CVD risk factors and diseases).	15.6	44.4	22.2	6.7	8.9	0.0	0.0	2.2
My workplace has the necessary infrastructure (e.g. space and equipment) to apply the current cardiovascular rehabilitation exercise guidelines in practice.	31.1	24.4	31.1	8.9	4.4	0.0	0.0	0.0
There are no barriers to applying the current cardiovascular rehabilitation exercise guidelines in my work practice.	11.1	26.7	33.3	11.1	13.3	2.2	0.0	2.2
I fully apply the current cardiovascular rehabilitation exercise guidelines in my work practice.	8.9	40.0	17.8	11.1	11.1	8.9	2.2	0.0
The current cardiovascular rehabilitation exercise guidelines are easy to read and understand.	6.7	33.3	22.2	17.8	11.1	6.7	0.0	2.2
The current cardiovascular rehabilitation exercise guidelines are specific to certain condition types.	6.7	33.3	24.4	22.2	6.7	4.4	0.0	2.2
I am aware when an update of the cardiovascular rehabilitation exercise guidelines is published.	6.7	13.3	13.3	15.6	33.3	8.9	6.7	2.2
I access and read any update of the cardiovascular rehabilitation exercise guidelines as soon as I am aware of it.	17.8	13.3	22.2	13.3	20.0	6.7	6.7	0.0
I apply new cardiovascular rehabilitation exercise guidelines very soon after they have been published.	6.7	24.4	20.0	13.3	22.2	6.7	6.7	0.0
The current cardiovascular rehabilitation exercise guidelines allow state-of-the art rehabilitation.	4.4	31.1	28.9	26.7	0.0	4.4	0.0	4.4
Do your work facilities affect your delivery of exercise prescription in cardiovascular rehabilitation?			**No** 63.6				**Yes** 36.4	
Do the type of patients/participants that you work with affect your decisions about exercise prescription in cardiovascular rehabilitation?			**No** 27.3				**Yes** 72.7	

Data are expressed as % of the total sample.
Note: Three out of 47 participants did not (fully) complete the statements.

involved in permanent education. The latter is particularly true in those physiotherapists holding a Ph.D.

These data indicate that more standardisation of exercise prescription by physiotherapists is warranted because suboptimal exercise prescription to patients with CVD (risk) is a very realistic scenario in current clinical practice. Some factors influencing the variance in exercise prescription might be reversible or directly related to the physiotherapists' adherence to, or knowledge of, clinical guidelines.

Table 4 Rating of the exercise prescriptions of the physiotherapists

	Score 0			Score 5			Score 10		
	1	2	3	1	2	3	1	2	3
Exercise intensity (%)	41.3	54.8	4.5	28.3	23.8	4.5	30.4	21.4	90.9
Exercise frequency (%)	76.6	77.3	75.0	14.9	9.1	13.6	8.5	13.6	11.4
Session duration (%)	4.3	9.1	6.8	4.3	4.5	15.9	91.5	86.4	77.3
Program duration (%)	35.7	74.4	66.7	2.4	7.7	10.3	61.9	17.9	23.1
Strength training (%)	12.8	9.1	6.8				87.2	90.9	93.2
Additional training (%)	80.9	47.7	56.8	14.9	47.7	43.2	4.3	4.5	0.0

MEAN TOTAL (SUB)SCORE PER CASE (mean ± standard deviation)
Case 1 ($n = 47$): 25.3 ± 9.6
Case 2 ($n = 44$: 23.2 ± 9.9
Case 3 ($n = 44$): 27.1 ± 10.6
MEAN TOTAL SCORE CASE 1 + 2 + 3 ($n = 43$): 76.4 ± 26.1

SCORE SUBCATEGORIES	Case 1	Case 2	Case 3
Score 0–15	**21.3%**	**29.5%**	**27.3%**
Score 16–30	**61.7%**	**54.5%**	**43.2%**
Score 31–45	**14.9%**	**15.9%**	**25.0%**
Score 46–60	**2.1%**	**0.0%**	**4.5%**

Data are expressed as % of the clinicians which scored 0–5–10 for case 1–2–3 or as mean ± standard deviation (for total scores) or as % of the clinicians which were subdivided into score subcategories.

Table 5 Overview of the three cases with EXPERT vs. physiotherapist proposed' prescriptions

	CASE 1 ($n = 47$) Acute myocardial infarction		CASE 2 ($n = 44$) AMI with CABG—COPD		CASE 3 ($n = 44$) Myocardial ischemic threshold @90—Frailty	
	EXPERT tool recommended prescriptions	Proposed participants' prescriptions	EXPERT tool recommended prescriptions	Proposed participants' prescriptions	EXPERT tool recommended prescriptions	Proposed participants' prescriptions
Intensity (HR, bpm)	82–102	99.0 ± 13.2 (68–130)	76–93	92.1 ± 11.3 (56–111)	≤90	81.8 ± 8.6 (55–95)
Frequency (sessions/ week)	7	3.8 ± 1.4 (2–7)	7	4.1 ± 1.5 (2–7)	7	4.2 ± 1.5 (2–7)
Session duration (min)	20–60	49.1 ± 13.3 (20–90)	20–60	48.5 ± 19.3 (20–120)	30–60	45.6 ± 16.1 (23–90)
Program duration (number of weeks)	>12	17.0 ± 9.8 (4–45)	>24	19.7 ± 9.1 (6–40)	>24	21.2 ± 10.7 (6–52)
Strength training	Yes	87.2% Yes	Yes	90.9% Yes	Yes	93.2% Yes

Continued

Table 5 *Continued*

	CASE 1 ($n = 47$) Acute myocardial infarction		CASE 2 ($n = 44$) AMI with CABG—COPD		CASE 3 ($n = 44$) Myocardial ischemic threshold @90—Frailty	
	EXPERT tool recommended prescriptions	**Proposed participants' prescriptions**	**EXPERT tool recommended prescriptions**	**Proposed participants' prescriptions**	**EXPERT tool recommended prescriptions**	**Proposed participants' prescriptions**
Total exercise volume (peak-effort training minutes)	—	2621.7 ± 1931.0 (450–9000)	—	3285.2 ± 2073.0 (540–8786)	—	3398.2 ± 2180.0 (297–8775)
Additional training modes	✓ **Strength training**: 2 days/week, 40–80% of 1RM, 12–15 reps/set ✓ **IMT** after CABG surgery (from 30 up to 60 of Pimax, 20–30 min/session, 3–5 days/week). Session: Start at 20 and go to 45 ✓ **>900 kcal/week of energy expenditure** should be achieved, ✓ Additional **isometric handgrip exercise training** is advised	isometric training, walking, gymnastics, isometric handgrip strength, cycling, aerobic endurance training, rowing, cross-trainer	✓ **Strength training**: 2 days/week, 40–80% of 1RM, 12–15 reps/set to 60–70% of 1RM, 8–12 reps/set. ✓ **IMT** after CABG surgery (from 30 up to 60 of Pimax, 20–30 min/session, 3–5 days/week). Session: Start at 20 and go to 45 ✓ Advice exercise modalities with large caloric expenditure (walking, jogging, stepping, etc.), **>900 kcal/week of energy expenditure** should be achieved ✓ Additional **isometric handgrip exercise training** is advised, ✓ **Muscle electro stimulation** and **inspiratory muscle training** (30% of Pimax, 20–30 min/session, 3 days/week) can be added. Session: M: 20–60; H: up to 6 cycles of 1 min, interspersed by 2-min active recovery, proceeded by 10 min warm-up. frequency: M: 3 up to 5; H: 2 up to 3	walking, yoga, cycling, cross-training, low-intensity interval training, isometric handgrip strength, breathing exercises/ respiratory training	✓ Advice exercise modalities with **large caloric expenditure** (walking, jogging, stepping, etc.), **>900 kcal/week of energy expenditure** should be achieved ✓ **Strength training**: 2 days/week, start at 30–70% 1RM (6–8 reps/set) and go to 70–85% 1RM (12 reps/set), at least 21 sets. ✓ **Electro muscle stimulation (EMS)** in case of significant muscle weakness can be added ✓ Additional **isometric handgrip exercise training** is advised ✓ **Balance training** or **tai chi** may be added. Intensity Start at L and go to M	walking, cycling, gymnastics, rowing, functional exercises/ ADL, balance training, low-intensity interval training, isometric handgrip strength training

Data are expressed as mean (minimum–maximum value); †missing data.
AMI, acute myocardial infarction; Bpm, beats per minute; CABG, coronary artery bypass grafting; min minute. COPD, chronic obstructive pulmonary disease; HIT, high-intensity interval training; IMT, inspiratory muscle training; min minute.

Moreover, the currently existing exercise recommendations do not mention how to integrate exercise prescriptions for different CVDs and risk factors within the same patient, making exercise prescription in clinical practice challenging. These factors are good candidates to be tackled in standardisation efforts, such as the EXPERT tool. The latter is currently a topic of ongoing investigation.

However, as CR always requires cooperation and interaction, we have to be aware that these cases only include objective patient information such as the CV diagnosis and risk factors and additional comorbidities. While prescribing CR to CVD patients, the personal situation (e.g. dependence of family members for transport to CR setting, financial limitations) and motivation to exercise (e.g. previous positive or negative experiences with exercise training, personal goals and exercise preferences) of the patient also has to be taken into account and may influence the final health outcomes.

This study may have been prone to some limitations. The study sample was small and further research is thus warranted to further explore these results in greater groups from various countries and settings.

Secondly, to calculate the agreement score from the participants, a score of 0, 5, or 10 was assigned to the exercise prescriptions for each modality. Notwithstanding previous studies already show that this agreement score can significantly improve after training with the EXPERT tool,[21] we acknowledge that this scoring method has not been validated in other studies, which can be considered as a limitation of this study.

Conclusions

In conclusion, physiotherapists' exercise prescriptions for CVD patients vary widely among themselves and are often in disagreement with European recommendations. These data confirm the need for standardisation efforts regarding integrated exercise prescription in CV rehabilitation.

Supplementary material

Supplementary material is available at *European Journal of Cardiovascular Nursing* online.

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Data availability

The authors confirm that the data supporting the findings of this study are available within the article [and/or] its *supplementary materials*.

Author contributions

Nastasia Marinus: Writing—original draft, Methodology, Formal analysis, Validation, Visualization, Véronique Cornelissen: Writing—review and editing. Raf Meesen: Writing—review and editing. Karin Coninx: Writing—review and editing, Project administration. Dominique Hansen: Writing—original draft, Methodology, Funding acquisition, Investigation, Project administration, Data curation, Conceptualization, Resources, Software, Supervision.

Ethics approval

The Hasselt University Ethics Committee(s) (registration number: CME2020/056) approved this study. All participants gave written informed consent before data collection began.

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