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Original Research

Blood Flow Restriction Use by U.S. Physical Therapists: A Survey on Settings, Equipment, and Adverse Effects

Alyssa M. Weatherholt‡[1], William R. VanWye†[2], Netra Patel*[1], Lexi Humphrey*[1]

[1]Kinesiology and Sport Department, University of Southern Indiana, Evansville, IN, USA; [2]School of Physical Therapy, Florida Southern College, Lakeland, FL, USA

*Denotes student investigator, ‡Denotes established investigator

Abstract

International Journal of Exercise Science 18(5): 736-746, 2025. https://doi.org/10.70252/ZJRV6089 Blood flow restriction (BFR) combined with exercise has been shown to enhance muscle hypertrophy, strength, and aerobic capacity. While previous studies have evaluated the use of BFR among various practitioners, none have investigated its use exclusively among licensed U.S. physical therapists (PTs). A cross-sectional survey was distributed electronically to licensed U.S. PTs. Participants were required to use BFR currently in clinical practice. Survey items included respondents' demographics, practice setting, exercise mode, the type of BFR equipment used, and adverse events. A total of 134 licensed PTs from 20 states completed the survey. BFR was most commonly used in outpatient orthopedic settings, primarily in conjunction with resistance exercises. The Delfi unit was the most frequently used device (64%). No major adverse effects reported (e.g., thrombosis, rhabdomyolysis, nerve damage). Minor adverse effects, including dizziness, numbness, nausea, and delayed onset muscle soreness, were reported by 8% of participants (n = 11). This survey found no major adverse effects and a low prevalence of minor, transient adverse effects. These findings are consistent with previous BFR safety literature and provide a foundational overview of BFR practices among U.S. PTs.

Keywords: Physical therapy, side effects, resistance training, occlusion training, rehabilitation

Introduction

Blood flow restriction (BFR) combined with exercise is an established method for improving muscle hypertrophy, strength, and aerobic endurance.[1–3] BFR with exercise involves applying a tourniquet-style cuff on the proximal part of a limb just before exercise. The cuff is then inflated to a pressure that restricts venous return while allowing partial arterial inflow. This approach is particularly advantageous in clinical settings where patients are unable to tolerate moderate- to high-intensity exercise.[4,5]

Common major adverse effects associated with BFR with exercise include the risk of thrombosis formation, exertional rhabdomyolysis, and nerve compression.[6,7] However, previous research has shown these adverse effects to be rare when BFR is applied correctly by trained

practitioners.[7–10] Another concern is an exaggerated exercise pressure reflex resulting in a hypertensive event.[11] Although BFR during low-intensity aerobic exercise results in higher systolic and diastolic blood pressures, these values do not necessitate the termination of exercise.[12,13]

Although previous studies have included physical therapists (PTs) within broader professional groups, to our knowledge, no prior research has specifically surveyed U.S. PTs regarding their use of BFR. Thus, this research investigated the utilization of BFR with exercise by PTs, encompassing aspects such as practice setting, exercise mode, the type of BFR equipment used, and adverse events.

Methods

Participants

Participants in this study were licensed U.S. PTs. Inclusion criteria required participants to provide informed consent, hold a current PT license to practice in the U.S., and use BFR with exercise. The University of Southern Indiana's Institutional Review Board approved this study, and participants provided informed consent prior to data collection. This research was conducted in accordance with the ethical standards of the *International Journal of Exercise Science*.[14]

Protocol

The survey was administered electronically via a Qualtrics XM link (Qualtrics, Provo, UT, USA) from February 2023 to October 2023. Licensed PTs were invited to participate through emails from state PT licensing boards. The survey consisted primarily of multiple-choice questions with branching logic that expanded based on participants' responses, requiring approximately 15 minutes to complete. The survey was used to collect the respondents' demographics (i.e., state, sex, age), practice setting, exercise mode, the type of BFR equipment used, and adverse events (Supplementary File 1). Although there was no formal survey validation, all questions were adapted and shortened from a previous BFR survey study.[10]

Statistical Analysis

Data were analyzed using Microsoft Excel 365 (Microsoft, Redmond, WA, USA). Descriptive statistics for participant characteristics, including means ± standard deviations (SD) and frequencies and percentages, were used to analyze all collected data.

Results

One-hundred and thirty-four surveys were collected. The average age of respondents was 38.9 ± 9.5 years. Of these, 96% combined BFR with resistance training, while 4% used it with aerobic training. Respondents represented 20 U.S. states, with the highest participation rates from Florida and Texas (Table 1). Seven practice settings were identified, with outpatient being the most common setting for BFR use among PTs (Table 2). Additionally, nine different BFR practice

areas were reported, with orthopedics being the most frequent (Table 3). Ten BFR cuffs were identified, with the Delfi unit being the most used (Table 4). No major adverse effects (e.g., thrombosis, rhabdomyolysis, or nerve injury) were reported. Minor adverse effects were reported by 8% of participants (n = 11). The most commonly reported minor adverse effects included dizziness (n = 6), numbness/tingling (n = 5), nausea (n = 4), and delayed onset muscle soreness (DOMS) (n = 3) (Figure 1).

Table 1. Physical Therapist Practicing State

State	Frequency	Percentage (%)
Florida	33	25
Texas	33	25
Ohio	17	12
Oregon	12	9
Wyoming	12	9
Michigan	6	4
Illinois	3	2
Missouri	3	2
Colorado	2	1
New Mexico	2	1
New York	2	1
Idaho	1	1
Indiana	1	1
Kentucky	1	1
Montana	1	1
Nevada	1	1
North Carolina	1	1
South Carolina	1	1
Washington	1	1
Wisconsin	1	1

Table 2. Physical Therapist Setting

Setting Type	Frequency	Percentage (%)
Outpatient	117	88
Academia	4	3
Home Health	4	3
Sports	3	3
In-patient	2	1
Military	2	1
School Setting	2	1

Table 3. Physical Therapist Practice Area

Practice Area	Frequency	Percentage (%)
Orthopedics	82	61
Sports	38	28
Generalist	5	3
Neurology	3	2
Pediatrics	2	2
Cardiovascular and Pulmonary	1	1
Home Health	1	1
Military	1	1
Women's Health/Pelvic Health	1	1

Table 4. BFR Cuff Type

Type of Cuff	Frequency	Percentage (%)
Delfi	86	64
Smart cuff	22	16
KAATSU	11	8
B Strong	7	5
Airband's	4	3
Hokanson Rapid Inflation System	3	2
Suji	2	1
Elastic	1	1
H+ Cuffs	1	1
Hawkgrip	1	1

*Percentages are based on the total number of respondents (N = 134). Participants could select more than one cuff type; therefore, totals exceed 100%.

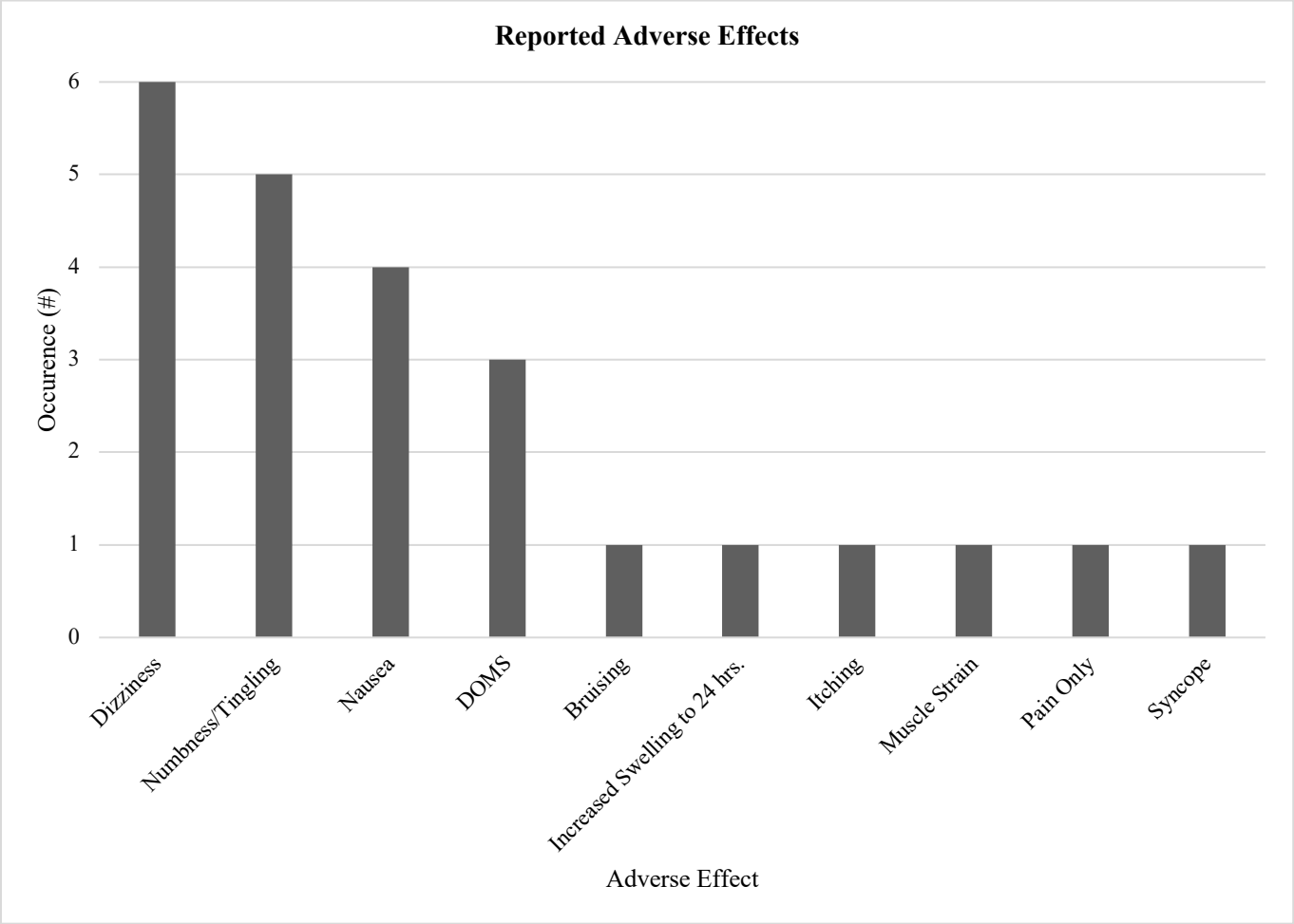

Figure 1. Reported adverse effects by physical therapists utilizing BFR with exercise.

Discussion

This study surveyed licensed U.S. physical therapists who use BFR with exercise to gain a better understanding of their practice settings, exercise modes, and the types of BFR equipment they use. The most commonly reported setting was outpatient orthopedics, and BFR was primarily used in conjunction with resistance training. The Delfi cuff was the most frequently reported device (64%). While market-wide usage data are limited, our findings suggest that Delfi is a prevalent choice among PTs utilizing BFR with exercise.

In addition, this study aimed to identify the types and prevalence of adverse effects associated with BFR in PT practice. There were no reported occurrences of thrombosis in this study. Cases of thrombosis associated with BFR with exercise have been reported in the literature, although it appears to be rare.[6] Surveys from 2006[7] and 2016,[8] involving over 25,000 participants, reported that the incidence of deep venous thrombosis was 0-0.055%, and pulmonary embolism was 0-0.008%. Overall, it does not appear that BFR with exercise exacerbates coagulation.[15] However, screening is recommended prior to using BFR with both healthy and clinical populations.[16]

There were no reported occurrences of exertional rhabdomyolysis in this survey. Although there are reported cases in the literature of BFR-induced rhabdomyolysis,[6–8] BFR with exercise does not appear to cause excessive muscle damage when applied appropriately. While BFR resistance exercise results in metabolic stress and transient muscle fatigue, markers of muscle damage, such as creatine kinase (CK), myoglobin (Mb), and lactate dehydrogenase (LDH), are not significantly elevated beyond the levels observed in traditional resistance training.[17–19] Notably, Winchester et al. (2020) demonstrated that when BFR was combined with high-intensity resistance training, muscular fatigue and perceived exertion were elevated, but excessive muscle damage did not occur.[18]

Lastly, there were no reports of nerve damage. It is well established that nerve alterations can occur directly due to tourniquet pressure and indirectly due to ischemia.[20] However, advances in tourniquet technology have significantly reduced the risk of nerve injuries by enabling personalized pressure adjustments. Thus, if personalized tourniquet systems are used with the appropriate cuff size, site, and pressure applied, BFR with exercise does not appear to alter nerve conduction or increase the risk of nerve injury.[9]

The most common minor adverse effects reported by the participants of our study included dizziness, numbness/tingling, nausea, and delayed onset muscle soreness (DOMS). Patterson and Brandner[10] also found that dizziness was a common adverse effect of BFR with exercise. Dizziness, or presyncope, is likely due to reduced venous return caused by the use of tourniquets, particularly when applied bilaterally. Decreased venous return reduces preload and, consequently, stroke volume.[21] As a result, this hemodynamic alteration can lead to symptoms such as dizziness.

Previous surveys have also found numbness/tingling to be common adverse effects of BFR during exercise.[7,8,10] This is likely due to peripheral nerve compression; however, it usually resolves quickly after the tourniquet pressure is released. As noted above, the incidence of

neurological symptoms and the risk of nerve injury can be mitigated by using personalized tourniquet systems and wider cuffs to achieve the lowest effective limb occlusion pressure.[20]

Nausea was a reported adverse effect in this study, consistent with Yasuda et. al.[8] Multiple mechanisms may explain this phenomenon. For example, nausea can occur during strenuous exercise due to gut ischemia,[22] as well as post-exercise due to hypotension, which can reduce blood flow to the gastrointestinal tract.[23] Additionally, the accumulation of lactic acid and hydrogen ions during intense exertion may disrupt gastric homeostasis and contribute to gastrointestinal discomfort.[24]

Lastly, DOMS was an adverse effect reported in our survey, consistent with Patterson and Brandner's findings.[10] DOMS is common after unfamiliar exercise, particularly when it includes numerous eccentric actions, which are known to cause microscopic muscle fiber damage that triggers an inflammatory response, leading to delayed soreness.[25] Symptoms typically resolve within 24-72 hours following unfamiliar exercise, with and without BFR.[26]

This study has several notable strengths. First, our findings regarding adverse effects closely align with previous survey data,[10] reinforcing the validity of our results. Additionally, to our knowledge, this is the first study to specifically survey U.S. PTs regarding their use of BFR and the prevalence of both major and minor adverse effects. This provides valuable insight into PT practice patterns. Furthermore, the study contributes to the growing body of literature on BFR safety, which may inform future guidelines and best practices.

However, several limitations should be considered. As a survey-based study, the accuracy of the responses depends on participants providing correct and honest information, which introduces the possibility of recall or reporting bias. Additionally, variations in BFR methodologies among U.S. PT, including differences in cuff type, prescription parameters, and patient conditions, could lead to inconsistencies in the data. Notably, detailed protocol information (e.g., occlusion pressure, sets, repetitions, duration) was not collected, which limited our ability to assess how specific application parameters may relate to the incidence of adverse effects. Furthermore, while demographic data were collected for the surveyed physical therapists, no information was gathered on the patients receiving BFR, making it unclear how individual health factors may have influenced reported outcomes. The survey also did not capture the number of BFR sessions per patient or whether multiple adverse events may have originated from the same individual, which limits the interpretation of event rates on a per-session or per-patient basis. Lastly, while these findings offer valuable insights into BFR use among U.S. PTs, they may not be generalizable to PTs in other countries or to other healthcare professionals utilizing BFR in their practice.

Although this study was not designed to evaluate standardized protocols, it provides a snapshot of real-world clinical practice among U.S. PTs. Future research should expand on these findings by including patient-level data along with details on cuff type, prescription parameters, and underlying patient conditions. The findings support the safety of BFR when applied by trained professionals, with no major adverse events reported and only a small proportion of minor, transient adverse effects. These results are consistent with previous large-scale surveys. As BFR

continues to be implemented in various settings and clinical populations, further research is warranted to explore patient-specific responses and practice guidelines to optimize safety and efficacy.

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Corresponding author: Alyssa M. Weatherholt, PhD; aweatherho@usi.edu

Supplemental File 1
Survey

Demographics
Provide the U.S. state you are licensed and practice the majority of your time as a physical therapist

▼ Alabama (1) ... Wyoming (51)

What is your age?

▼ 20 (1) ... 90 (71)

What is your sex?

▼ Male (1) ... Prefer not to say (4)

In which of the following practice settings do you spend the majority of your time?

- ○ Academia
- ○ Home health services
- ○ In-patient (hospital, short-term acute care)
- ○ In-patient rehab facility/acute rehabilitation unit
- ○ Long term acute care hospital (LTACH)
- ○ Outpatient
- ○ School services
- ○ Skilled nursing facility
- ○ Other _____

BFR Use

Do you use BFR in your clinical practice?

- ○ Yes
- ○ No

What is your primary clinical practice area that you use BFR?

- ○ Neurology
- ○ Orthopedics

- ○ Cardiovascular and Pulmonary
- ○ Clinical Electrophysiology
- ○ Generalist
- ○ Oncology
- ○ Pediatrics
- ○ Sports
- ○ Women's Health/Pelvic Health
- ○ Wound Management
- ○ Other _____

What is the type of BFR Cuff used?

- ○ Kaatsu
- ○ Delfi
- ○ Hokanson Rapid Cuff Inflation System
- ○ Other _____

What is your primary exercise use of BFR?

- ○ Aerobic exercise
- ○ Resistance exercise
- ○ Other _____

Have there been any adverse events during the use of BFR exercise?

- ○ Yes
- ○ No

If there were adverse events when using BFR exercise, what were the events

- ☐ Localized Bruising
- ☐ Numbness/Tingling
- ☐ Blood Clot
- ☐ Pain
- ☐ Itching
- ☐ Nausea
- ☐ Dizziness
- ☐ Rhabdomyolysis
- ☐ Cold feeling
- ☐ Delayed onset muscle soreness
- ☐ Other

If other was selected for adverse events what were the other?

_____