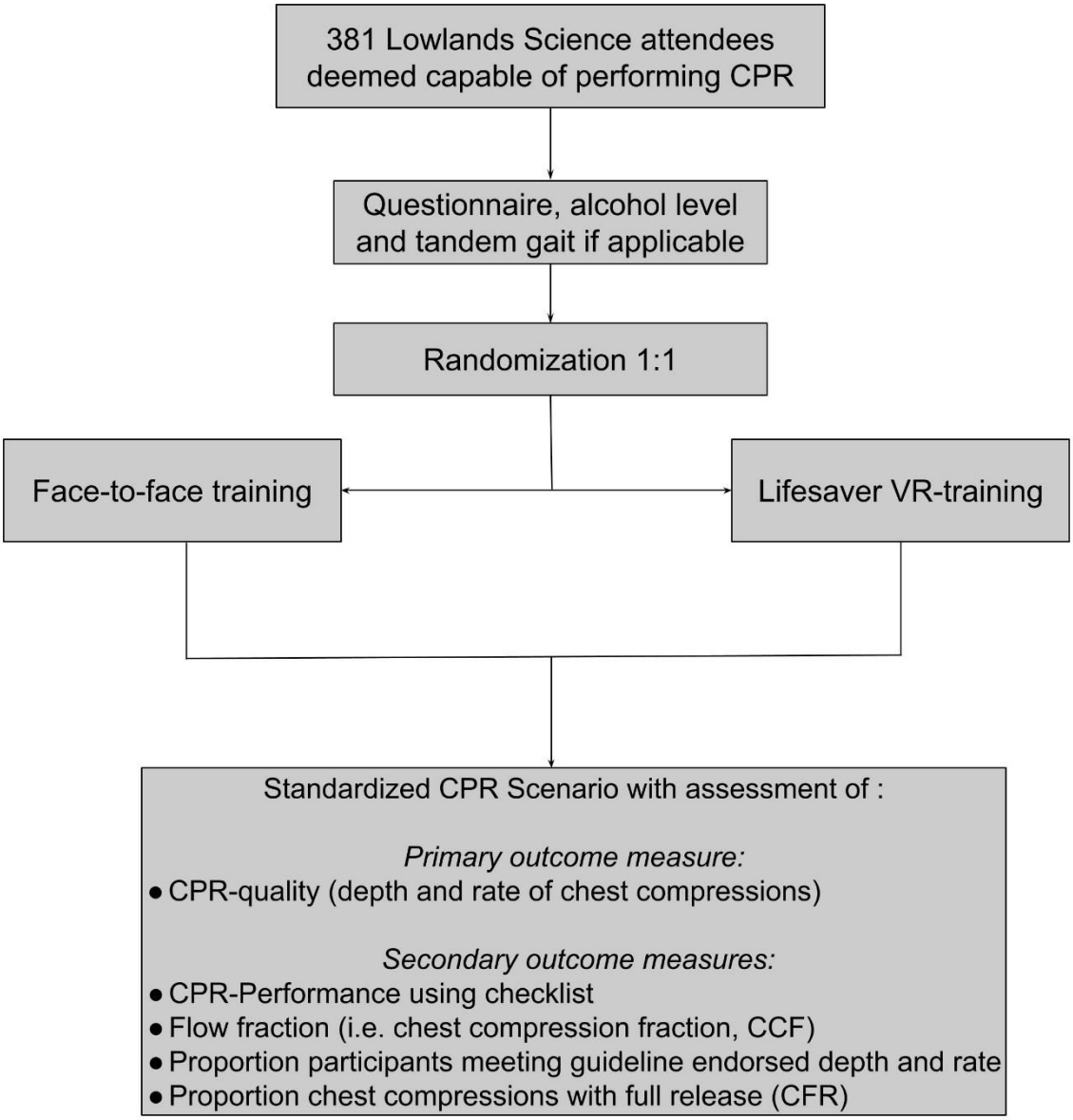
Supplementary Online Content

Nas J, Thannhauser J, Vart P, et al. Effect of face-to-face vs virtual reality training on cardiopulmonary resuscitation quality: a randomized clinical trial. *JAMA Cardiol*. Published online November 17, 2019. doi:10.1001/jamacardio.2019.4992

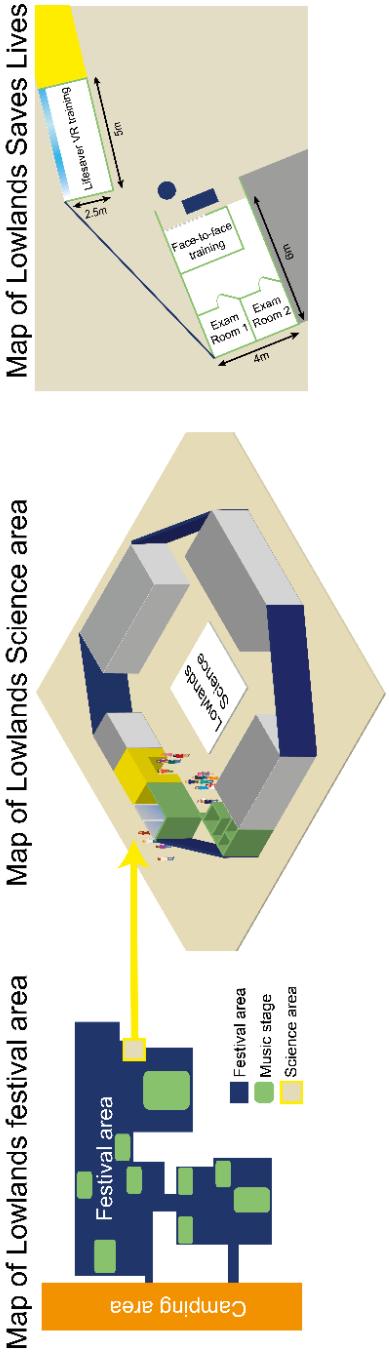
This supplementary material has been provided by the authors to give readers additional information about their work.

eFigure 1. Study flowchart



Study flowchart. VR = virtual reality, CPR = Cardiopulmonary resuscitation.

eFigure 2. Graphical impression of the study setting



Schematic representation of the study setting. Lowlands Science was an area on the Lowlands festival that was separated from the rest of the festival. Several studies were conducted on Lowlands Science. The square footage of the area for study conduction was pre-specified and could not be expanded.

eAppendix 1. Training protocols

Lifesaver Virtual Reality (VR) training

The Lifesaver VR-training was performed in a room that was separated from the rest of the study setting. All participants used the same VR set-up, which consisted of a Samsung S7 smartphone, Zeiss VR One Plus goggles and headphones. The Lifesaver VR app was pre-installed on all phones. A dedicated research physician provided instructions with regard to study procedures. Participants were asked to complete the entire scenario and were told to not discuss their training with the examiner. All participants completed the same scenario, which consisted of performing cardiopulmonary resuscitation (CPR) on a friend that collapsed during playing football. Chest compressions were practiced on a pillow. The app provided real-time feedback on chest compression rate, and instructions on chest compression depth. Participants were given no additional instructions or information on CPR, besides the instructions given by the Lifesaver VR-training scenario.

Participant demonstrating the VR set-up during study conduction.

In-game footage from the Lifesaver VR-application

Overview of the resuscitation scenario that was done by participants randomized to the Lifesaver VR-training. The user assumes the role of the young woman who is performing chest compressions on the cardiac arrest victim, who is her friend.

Point-of-view screenshot, which is the image that participants see while practicing chest compressions. Both images reproduced with the kind permission of the Resuscitation Council (UK).

Face-to-face training

The face-to-face training sessions were given in a room that was physically separated from the rest of the study set-up. A standardized, short basic life support (BLS) training was designed under supervision of our National Course Director BLS. The training consists of similar elements as a previously reported, short CPR-training course.[1] We adhered to the current European Resuscitation Council guidelines on CPR-education, by focusing on the following four points:[2]

- Willingness to start CPR, including an understanding of personal and environmental risk
- Recognition of unconsciousness, gasping or agonal breathing in unresponsive individuals by assessment of responsiveness, opening of the airway and assessment of breathing to confirm cardiac arrest.
- Good quality chest compressions (adherence to rate, depth, full recoil and minimizing hands-off time) and rescue breathing (ventilation time and volume)
- Feedback/prompts (human feedback within the CPR-team and/or from devices) during CPR-training to improve skill acquisition and retention during basic life support training.

Participants were told not to discuss their training with the examiner. For the training we used Laerdal Little Anne CPR-manikins, and used Zoll AED Trainer 3 training AEDs for practicing AED-skills.

The following steps were followed during all training sessions:

Time from start (min.)	*Description*
0-2	Brief background on cardiac arrest and the importance of CPR to improve (neurologic) outcome
2-4	Recognition of unconsciousness, gasping or agonal breathing in unresponsive individuals by assessment of responsiveness, opening of the airway and assessment of breathing to confirm cardiac arrest.
4-6	The importance of calling the EMS and retrieving an AED
6-10	Interactive demonstration of CPR-sequence and good-quality CPR.
10-12	Explanation and demonstration of AED use.
12-19	Practicing of CPR-skills on CPR-manikins, during which feedback will be provided by instructor.
19-20	Summary of steps and the importance of additional (re-)training

These steps were available on a checklist for the instructor, hanging on the wall as a poster, to ensure similarity of all training sessions.

Face-to-face training as performed during the study.

eAppendix 2. Post training CPR-test protocol

For the post-intervention assessment, we used the following standardized scenario.[3]

The participant would enter the room where the assessment took place. In this room, a Resusci Anne QCPR (Laerdal Medical, Stavanger, Norway) full body manikin lay on the floor. Assessors were blinded for study group. The assessor asked whether permission was given for the video recording, and started recording if this were the case. The assessor would read out the following text:

"You are at work. A colleague looks pale, puts her/his hand in the middle of her/his chest and says, I have chest pain and then suddenly collapses in front of you. Act as if it was a real-life situation".

In the scenario, the assessor was silent, only helped to call 112 if asked and brought the AED to the scene two minutes from the start (with at least 3 cycles of chest compressions, if the participants started chest compressions). After using the AED, the assessor terminated the scenario. No feedback was given to any participants during the testing. After the testing, short feedback on CPR-performance was given to the participants.

All interactions between participants and the manikin, including chest compression parameters, were recorded by the Resusci Anne QCPR-manikin, collected by the SimPad recording device, and downloaded to a remote laptop for analysis.

The required steps for performing adequate CPR were scored using the European Resuscitation Council-endorsed BLS assessment checklist (see next page).

EUROPEAN RESUSCITATION COUNCIL

2016.V2

BLS assessment record

Candidate Name: Date: Instructor:

Skill	The candidate	Achieved Yes	Achieved No	Comments
Check response	Demonstrates gently shaking and shouting to establish responsiveness			
Assess breathing	Demonstrates head tilt and chin lift			
Assess breathing	Demonstrates look, listen and feel for normal breathing for no more than 10 sec (does not count aloud)			
Call emergency services (Get help)	Describes how to phone for emergency services: 112, unresponsive and non-breathing victim, AED			
Chest compressions	Demonstrates effective chest compressions; rate 100-120/min, depth 5-6 cm; hand position: centre of the chest. Minimises interruptions in chest compressions			
Rescue breaths	Demonstrates rescue breaths sufficient to cause the chest to rise and fall			
Compression : ventilation ratio	Demonstrates ratio of 30 compressions to 2 ventilations			
Activate AED	Switch the AED on or, if a helper is present, ask him/her to do it			
Attach pads	Demonstrates attaching pads in correct position			
Stand clear	Allows rhythm analysis whilst making sure that nobody touches the victim (including visual sweep and verbal instruction)			
Deliver shock	Demonstrates rapid and safe delivery of a shock (including visual sweep and verbal instruction to stand clear)			
Follow AED instructions	Demonstrates listening to and executing AED instructions			
CPR	Minimises interruptions in chest compressions and demonstrates correct sequence in ratio of 30 compressions to 2 ventilations			

eTable. Individual components of the CPR-performance checklist

	Lifesaver VR (n=175)	Face-to-face (n=176)*	p-value
CPR			
Check response	107 (61%)	170 (97%)	<0.001
Assess breathing (head tilt and chin lift)	100 (57%)	160 (91%)	<0.001
Assess breathing (look, listen, feel)	147 (84%)	167 (95%)	0.001
Call EMS	97 (55%)	162 (92%)	<0.001
Chest compressions	114 (65%)	151 (86%)	<0.001
Rescue breaths	100 (57%)	157 (90%)	<0.001
Compression : ventilation ratio	131 (75%)	168 (96%)	<0.001
AED use			
Activate AED	86 (50%)	118 (67%)	0.001
Attach pads	152 (87%)	169 (97%)	0.002
Stand clear	159 (91%)	166 (94%)	0.29
Deliver shock	167 (96%)	173 (98%)	0.22
Follow AED instructions	172 (99%)	175 (99%)	0.62
Resume CPR	148 (86%)	172 (98%)	<0.001

* *In one participant, the results from the CPR-performance checklist are missing. CPR = Cardiopulmonary resuscitation, VR = Virtual reality, EMS = Emergency medical services, AED = Automated external defibrillator*

eReferences

[1] L.P. Roppolo, P.E. Pepe, L. Campbell, et al. Prospective, randomized trial of the effectiveness and retention of 30-min layperson training for cardiopulmonary resuscitation and automated external defibrillators: The American Airlines Study. Resuscitation 2007;74:276-85.

[2] R. Greif, A.S. Lockey, P. Conaghan, et al. European Resuscitation Council Guidelines for Resuscitation 2015: Section 10. Education and implementation of resuscitation. Resuscitation 2015;95:288-301.

[3] H. Bylow, T. Karlsson, A. Claesson, et al. Self-learning training versus instructor-led training for basic life support: A cluster randomised trial. Resuscitation 2019;139:122-32.