

# **Assessing the Physiological and Psychological Impacts of Head-Hold Restraint Techniques**

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# Acknowledgements

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# Executive summary

## Background

Secure establishments for young people must have in place strategies for managing challenging behaviour. The aim is to minimise the need for restraint, but, where necessary, it is essential that staff apply restraint techniques as effectively and safely as possible within the legislative framework, and in the best interest of the young person.

In response to the 2008 Independent Review of Restraint, the government introduced Minimising and Managing Physical Restraint (MMPR) – a new behaviour management system including a set of new restraint techniques for use in secure training centres (STCs) and under-18 young offender institutions (YOIs). The syllabus was developed by the National Offender Management Service (NOMS), and the first establishment went live with MMPR in March 2013. At the time of writing, the process of replacing existing systems with MMPR was ongoing, with its roll-out intended to be completed by the end of 2015.

A Restraint Advisory Board (RAB) was established to assess MMPR for use in STCs and under-18 YOIs. In 2011, the RAB recommended that independent research be conducted to seek alternative head-hold restraint techniques and assess the level of risk associated with these techniques.

This study was commissioned by the Youth Justice Board in 2013, and was conducted by the University of Coventry.

## Aims

The aim of this research project was to compare the physiological and psychological impact of four different head-hold techniques, with a view to identifying the lowest risk approach.

## Approach

The study examined four head-hold restraint techniques (including the MMPR head-hold) in a laboratory setting using a repeated measures design (i.e. testing all the positions on every participant).

A purposive sample of 22 young adult students (aged 18–24 years) attending Coventry University volunteered to take part in the study, which was approved under the Coventry University ethics review procedure. Written informed consent and health declarations were obtained from all participants prior to them taking part.

Overall, each participant was tested in 12 positions (see Annex 1 for full details), which were split over two sessions as a precaution to avoid fatigue. Each head-hold restraint technique was tested in a standing position with participants bent over at two different angles of forward leaning, i.e. 30 degrees and 70 degrees. In each session, participants were also tested in a standing control position and in a standing position with arms restrained but no head-hold applied (to establish their normal physiological

measures). The order of the positions was randomised in an effort to minimise any fatigue effects.

Lung function, heart rate and blood pressure were measured in each position. Participants also provided self-reported ratings of their psychological experiences and ranked the four head-hold techniques in order of their overall preference.

The following limitations need to be borne in mind when interpreting findings:

- As a laboratory study which tested restraint positions in passive conditions (i.e. at rest with no exercise or struggling), this research was not able to fully replicate the use of restraint in the real world. It did, however, allow for measurement in controlled conditions, which would not be possible during incidents in custody.
- The use of a purposive sample of young adult students (aged 18–24) means that the results may not be representative of the wider population of interest (i.e. young people in custody) and, as such, need to be interpreted with some caution. They are, however, useful in providing an indication of the likely impact of using different head-hold techniques and any additional impact of leaning on young people.

## Findings

The physiological testing resulted in the following key findings:

- The restraint positions did not cause any statistically significant reductions in lung function. The changes observed were also considered to be consistent with those that people might encounter in their normal lives.
- Changes in cardio-vascular variables were also small and, while some statistically significant results were obtained, these were deemed by the authors to be within the variation which might be expected during normal life.

Participants' ratings of their experiences during restraint provided the following insights:

- Participants gave significantly different ratings of the positions for 'pressure or pounding in the head,' 'difficulty breathing,' 'invasion of personal space,' and 'overall discomfort.' However, all ratings were relatively low (i.e. in no case rising above 3 on a scale of 0 to 4) and none were rated as 'severe' (as indicated by a rating of 4).
- Participants' ratings indicated that being held bent forwards at 70 degrees was more uncomfortable than being held at the more upright (30 degree) angle.
- The participants' rankings also suggested a preference for a head-hold technique where they were held at arm's length (referred to as 'amended head-hold 2').

## Conclusions

The overall conclusion drawn from this laboratory-based study was that none of the head-holds, as tested, caused significant changes in physiological measures, which would be beyond those that might be experienced in normal life.

Participants reported less discomfort in the more upright restraint positions. While it may not always be possible to restrain a young person in an upright position during a

real restraint incident (as this may fail to control behaviour such as kicking), it is reasonable to recommend that restraint be carried out in the most upright position which is possible in the circumstances.

Overall, participants reported less discomfort and showed a general preference for a head-hold technique where they were held at arm's length ('amended head-hold 2'). While this head-hold appeared to offer some advantages over the other three techniques, it has not been tested to ascertain if it would be effective in controlling aggressive behaviour. It is therefore recommended that this position should be examined for practical effectiveness, and only be brought into operational use if there is confidence that it is safe (for staff as well as the young person) and effective.

While conducting the study, the authors observed a potential limitation to breathing if head-holds were misapplied resulting in the restrained person's mouth being held closed. Further research would be required to identify the precise effects of this. However, it is recommended that this potential misapplication of restraint is highlighted and warned against in MMPR training materials, and explicitly emphasised during MMPR training.

## **Recommendations**

The following recommendations regarding head-hold restraint techniques are based on the findings from the psychological ratings in this study, which suggest that to improve the comfort of those restrained, the following should be applied:

1. Restraint should be carried out in the most upright position possible in the circumstances.
2. A head-hold technique with the young person held at arm's length (referred to here as 'amended head-hold 2') should be subject to further review and development by NOMS. This technique should only be brought into operational use if there is confidence that it is safe (for staff as well as the young person) and effective.

In carrying out the study, the authors also identified a potential issue in using head-hold restraint techniques, which may have safety implications for their use:

3. The potential for misapplication of restraint, resulting in the mouth being held closed, should be highlighted and warned against in MMPR training materials, and explicitly emphasised during MMPR training.

# Context

## Background to the research

Secure establishments for young people must have in place strategies for managing challenging behaviour. The aim is to minimise the need for restraint but, where necessary, it is essential that staff apply techniques as effectively and safely as possible within the legislative framework,<sup>1</sup> and in the best interest of the young person.

In response to the Independent Review of Restraint (2008),<sup>2</sup> the government introduced a new behaviour management system including a new set of restraint techniques – Minimising and Managing Physical Restraint (MMPR) – for use in secure training centres (STCs) and under-18 young offender institutions (YOIs). The syllabus was developed by the National Offender Management Service (NOMS), and the first establishment went live with MMPR in March 2013. At the time of writing, the process of replacing the existing systems with MMPR was ongoing, with roll-out intended to be completed by the end of 2015.<sup>3</sup>

As part of MMPR, a young person may, if necessary, be restrained in a standing position. This will usually be carried out by two members of staff, each holding one of the young person's arms. Holding the young person's head is not mandatory or routine and should only be used in response to specific increased levels of risk. The MMPR manual states that: 'The application of the head-hold will normally only be required if the young person is so violent that not controlling the young person's head would place them, or staff at risk.'<sup>4</sup>

In incidents where it is necessary for a third member of staff to hold the young person's head, this third member of staff will also:

1. *“Protect and support the head and neck of the young person*
2. *Monitor the medical condition of the young person, identifying any specific warning signs as outlined in Volume 3 and take appropriate action”*

(Ministry of Justice/National Offender Management Service 2012: volume 5, p.33).

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<sup>1</sup> Further details on the government's policy on restraint can be found in Ministry of Justice (2012) *Use of Restraint Policy Framework for the Under-18 Secure Estate*. London: MoJ.

<http://www.justice.gov.uk/downloads/youth-justice/custody/mmpr/use-restraint-policy-framework.pdf>

<sup>2</sup> Smallridge, P. and Williamson, A. (2008) *Independent Review of Restraint in Juvenile Secure Settings*. London: HMSO.

<https://www.education.gov.uk/publications/eOrderingDownload/Review%20of%20restraint.pdf>

<sup>3</sup> Additional information on MMPR and progress on implementation can be found at:

<https://www.gov.uk/government/publications/behaviour-management-and-restraint-work-programme-update>

<sup>4</sup> Reasons may include: the young person threatening violence to staff or others; the location – stairs or vulnerable areas for staff; the young person spitting; the young person using their legs as a weapon or impeding staff (kicking etc). For further detail see Ministry of Justice/National Offender Management Service (2012): volume 5, p.32.

<http://www.justice.gov.uk/downloads/youth-justice/custody/mmpr/mmpr-vol5-physical-restraint.pdf>

Secure establishments using MMPR currently report any serious injuries and warning signs that occur during and after a restraint incident to NOMS.<sup>5</sup> Practitioners are aware of the warning signs, and monitor young people for these during incidents of restraint:

1. Complaints of difficulty in breathing
2. Complaints of feeling sick
3. Difficulty breathing
4. Vomiting
5. Lost or reduced consciousness
6. Blueness of lips/fingernails/earlobes (cyanosis)
7. Abruptly/unexpectedly stopped struggling or suddenly calmed down
8. Tiny pin point red dots seen on the skin (upper chest, neck, face, eye lids).<sup>6</sup>

The YJB also collects and publishes information on every instance of the use of force carried out under MMPR, to further its understanding of how MMPR is being used by the secure establishments.<sup>7</sup>

A Restraint Advisory Board (RAB) was established to assess MMPR for use in STCs and under-18 YOIs. Their 2011 report made a series of recommendations to Ministers regarding the safety and appropriateness of the MMPR syllabus, and use of the head-hold technique in particular, including:

*“Approval for use of the head-hold technique should be conditional upon the immediate establishment of an independent and rigorous research project tasked with seeking to identify a better alternative(s) and assessing comparative risks of any such alternative(s). This step is recommended as clear acknowledgement of the legitimate concerns about the risks associated with this technique and in recognition that it is used very extensively across the secure estate”*

(Restraint Advisory Board 2011: Recommendation 16)

In response to this recommendation, the Youth Justice Board (YJB) in 2013 commissioned a research team at the University of Coventry to conduct this study.

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<sup>5</sup> Further details of MMPR safeguarding processes, governance arrangements, and roles and responsibilities are available at:

<http://www.justice.gov.uk/downloads/youth-justice/custody/mmpr/minimising-managing-physical-restraint.pdf>

<sup>6</sup> See Youth Justice Board (2014) *Statistical Notice: Minimising and Managing Physical Restraint (MMPR) Data Collection March 2013 – March 2014*. Available:

[https://www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/368350/minimising-and-managing-physical-restraint-data-collection.pdf](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/368350/minimising-and-managing-physical-restraint-data-collection.pdf)

<sup>7</sup> Ibid.

## Aims

The aim of the research was to test the physiological and psychological effects of four head-hold techniques, including the one currently used in the MMPR system, with a view to identifying the least risky position. This research project was commissioned to identify any possible risks to the individual being restrained, and also to suggest ways in which the current guidance and practice could be improved.

## Previous research

The physiological and psychological measures employed in this study were selected in light of the recognised warning signs and symptoms for use of restraint in the secure estate for children and young people, and the research evidence currently available on restraint. The effects of restraint on both lung function (breathing) and the cardiovascular system (heart and blood circulation) have been studied in previous research. This section gives a brief overview of some of the findings from the most relevant literature relating to these measures, but is not intended to be an exhaustive or systematic review. All are based on laboratory studies, which involved adult participants, as there are ethical concerns about conducting this type of research with young people under the age of 18.

There is a good body of research available on prone restraint positions (i.e. where the person being restrained is lying face down on the floor) showing changes in lung function. For example, Chan et al. (1997) tested a series of restraint positions lying on the ground, which were used as part of police procedures employed in the United States. They found that restraint lying in a face-down position or prone position resulted in reductions in lung function, but did not cause any effects on oxygen levels in the blood. A specific prone restraint position – the ‘hobbled prone’ or ‘hog-tie’ position<sup>8</sup> – had been associated with fatalities following its use and this position showed the greatest reductions in lung function. The same group of researchers repeated this study, but with the addition of forceful exercise or weight placed on the restrained person. Again, they found reductions in lung function, but no significant changes in blood oxygen levels (Michalewicz et al., 2007).

Parkes and Carson (2008) tested the effects of several restraint positions which involved lying on the ground. Some (but not all) prone restraint positions were found to cause significant reductions in lung function, with decreases approaching 30% found in the most restrictive positions.

Barnett et al. (2013) tested three prone restraint positions, including one prone position intended to reduce pressure on the chest. In addition to lung function testing, they examined blood oxygen levels and the pressure exerted on the participant’s chest from the floor. The authors reported reductions in lung function during prone restraint, with the more supportive prone position causing slightly less reduction. The decreases recorded also varied in proportion to the pressure on the chest. As with Chan et al. (1997), no changes in blood oxygen levels were detected.

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<sup>8</sup> ‘Hobbled prone’ or ‘hog-tie’ has the arrestee’s hands handcuffed behind their back while lying face down on the floor. The arrestee’s ankles are also restrained, the legs bent at the knees, pulling the feet towards the buttocks and the ankles joined to the wrists. Incidents associated with this technique are reported in relation to US law enforcement.

Thus far, most research has focused on prone restraint positions. However, the effects of some seated restraint positions have also been tested. Vilke et al. (2011), for example, examined the effects of a restraint chair<sup>9</sup> on lung function and blood oxygen levels. They found small reductions in lung function, but no effect on blood oxygen levels. Parkes, Thake and Price (2011) tested manual restraint (restraint involving an individual being held by people rather than straps) in a seated position. They reported that restraint performed with a person sat upright had little effect, but pushing the person forwards with their chest towards their knees caused large (mean reductions of up to 50%) and potentially dangerous reductions in lung function.

Only one other study to date has included testing of standing restraint techniques (Parkes, Thake and Price 2009). This study included restraint in a standing position both with and without a head-hold applied. It identified small reductions in lung function (e.g. of less than 4%).

The study outlined in the current report expands on the previous project by Parkes, Thake and Price (2009), testing four different head-holds in a standing position, and at different angles of leaning. In addition to lung function, the study also examined the impact on heart rate and blood pressure.

While there are several studies of the effect of restraint on breathing, less work has been reported on the effects of restraint on the heart and circulation (i.e. cardio-vascular effects). Roeggla et al. (1997), for instance, tested the hobbled prone position using both lung function testing and cardio-vascular measurement. Hobbled prone restraint was found to cause a reduction in lung function of about 40%. Cardiac output (the volume of blood pumped by the heart during one minute) was reduced by 37%.

Ho et al. (2011) studied the effect of prone restraint on the diameter of the participants' inferior vena cava (a large vein which returns blood from the lower body, through the abdomen, to the heart). Measurement was carried out on restraint in standing and prone positions, and also prone positions with two different levels of weight placed on the participant. The vena cava diameter was reduced in the prone position and was further reduced by the addition of weight on the participant's back. However, this was not sufficient to induce significant changes in vital signs, such as heart rate or blood pressure.

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<sup>9</sup> A restraint chair is a robust, metal and/or plastic chair in which a resistant person may be restrained using straps and/or handcuffs. These devices are used in some US police/prison detention facilities.

# Approach

The methodological approach used in this study is set out below.

## Testing the restraint positions

A purposefully selected sample of 22 young adults (8 male and 14 female)<sup>10</sup> attending Coventry University took part in the study.<sup>11</sup> The study used a 'repeated measures' design, which involves each participant being tested in all positions (12 in total) and, as a result, does not require large numbers of participants in order to detect an effect. The physical characteristics of the participants are shown in Table 1.

**Table 1: Physical characteristics of the participants**

	Age (Years)	Height (cm)	Weight (kg)	Waist <sup>12</sup> (cm)	BMI (kg/m <sup>2</sup> )
<b>Average (mean)</b>	20	169	73	82	25.5
<b>Range</b>	18 - 24	158 - 180	56.4 - 105.3	72 - 102	20.4 - 35.2

Potential participants were made aware of the study and given the opportunity to volunteer. The age requirement of potential participants was specified as between 18 and 25 years, to ensure that the participants were close in age to the youth justice population, but could give valid consent as adults. A written health declaration was completed before participation. Any volunteer with health conditions which raised concerns for safety or accurate results was not eligible to take part (no such exclusions were made in this study).

Height, weight and waist measurement were recorded for each participant. Body mass index (BMI) was also calculated from each participant's height and weight.

The study tested four head-hold restraint techniques identified by NOMS personnel to reflect a range of the different types of head-holds in operational use across settings. A qualified instructor from the NOMS MMPR national training team attended the

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<sup>10</sup> Although there is currently a larger proportion of males in the secure estate for children and young people, gender was not expected to exert a differential effect on measures in this study. As a result, no quotas were set according to the gender of participants.

<sup>11</sup> A sample size of 22 was chosen based upon power analysis of results from a previous study of a similar design (Parkes and Carson, 2008). Twenty participants gives a 90% probability of detecting a 10% change in lung function at the  $p < 0.05$  level of significance. Two additional participants were recruited to allow for drop-out or exclusion (none occurred). As no previous study has employed the same methodology as this study, the power calculation was necessarily based on methodology previously employed. As there are differences between the two approaches, there are some limitations with the power calculation, although it provided a useful indicative measure.

<sup>12</sup> Waist measurement was taken at umbilicus (navel or belly-button) level.

university and taught the necessary restraint techniques to the researchers in order to ensure correct application.

The following illustrations show the four head-hold techniques tested. Every test of a head-hold was conducted with:

- both of the participant's arms restrained
- each arm restrained by a separate researcher stood to each side of the participant
- the head held by a third researcher, stood to the front of the participant.

Figure 1: Illustrations of the four head-hold techniques tested with both participant's arms restrained in the study, demonstrated by Coventry University Staff.

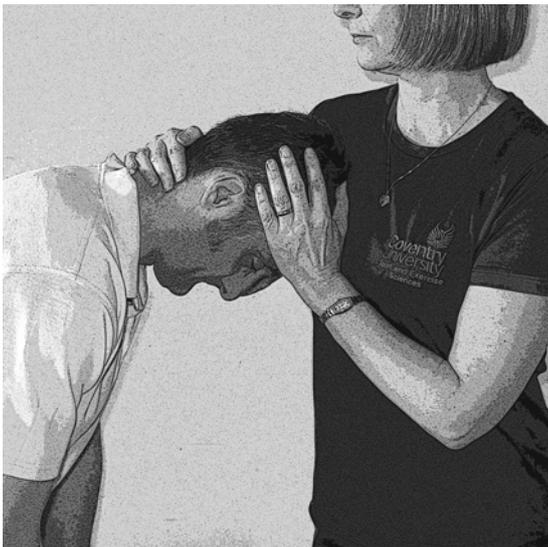


Illustration 1: MMPR head-hold (MMPR)

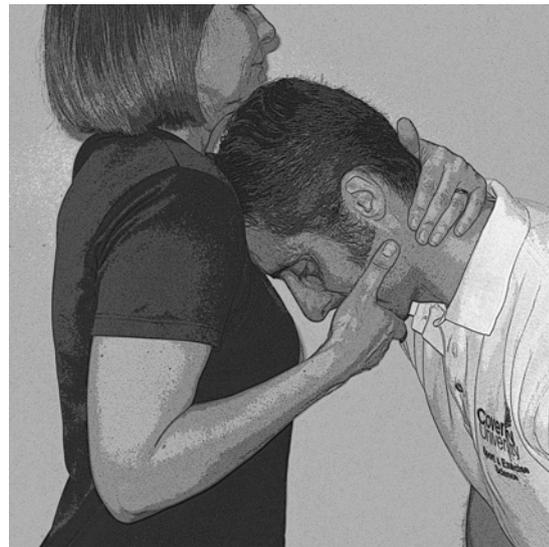


Illustration 2: Amended head-hold 1 (AHH-1)



Illustration 3: Amended head-hold 2 (AHH-2)



Illustration 4: Amended head-hold 3 (AHH-3)

Note: Illustrations show only the head-hold techniques. In every test of a head-hold during this study, the participant's arms were also restrained by two researchers, one standing each side of the participant. The head was held by a third researcher, standing to the front of the participant. The persons holding the arms are not shown in these illustrations, in order to allow a clear view of the actual head-holds.

The effect of bending the restrained participant forwards was also examined, as this commonly occurs during real-life restraint incidents, and bending has been shown to affect breathing in previous studies (Parkes, Thake and Price, 2011). Each head-hold was tested with the participant bent forwards to an angle of 30 degrees and to an angle of 70 degrees.<sup>13</sup>

Physiological measurements were also taken in a standing, upright, unrestrained, position to allow comparison with the participant's natural lung function, heart rate etc (referred to here as the 'standing control position'). A second set of measurements was taken in the standing control position later in testing to control against any fatigue effects. This gave a total of 12 positions (see Annex 1 for a full list of positions).

Figure 2: Illustrations of the two angles of lean utilised in the study, demonstrated by Coventry University staff.



Illustration 5: 30 degree angle of lean



Illustration 6: 70 degree angle of lean

Note: Illustrations show staff members acting as participants. Lung function testing apparatus is in place in the mouth. A continuous, real-time monitoring system for heart rate and blood pressure is in place on wrist, with sensor on finger. Three Coventry University staff hold the participant (two holding arms and one holding head). Amended head-hold 2 (AHH-2) is shown in both illustrations.

Each of the 22 participants was tested in all of the 12 positions.<sup>14</sup> The order of the positions was randomised to prevent any distortion of the results due to fatigue. As a further precaution against fatigue, testing was also conducted in two sessions of six tests, with a rest break between sessions.

All testing was conducted at rest, i.e. there was no exercise or struggling. Some previous studies have used exercise and/or struggling (Michalewicz et al. 2007).

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<sup>13</sup> The angle of leaning was measured using an angled arm attached to a vertical frame. The angle was measured from vertical to a line from hip to shoulder of the leaning participant.

<sup>14</sup> In each test, 1) the participant was restrained; 2) there was a period of quiet breathing; 3) lung function was then measured; 4) this was followed by more quiet breathing; 5) a second lung function measure was taken; 6) this was followed by more quiet breathing; 7) a third lung function measure was taken; 8) this was followed by more quiet breathing; 9) cardio-vascular readings were recorded; 10) the participant was released from restraint. Total period: approximately four minutes.

However, they have produced little additional information than studies which did not employ this approach.

In each position, the following measurements were taken:

- **Lung function.** Participants were taught the breathing technique required for lung function testing (a forced breath in, then out, as fast and fully as possible) and then allowed to practice this prior to measurements being recorded for the study. Participants were verbally encouraged during testing, as lung function measurements can be influenced by the level of effort. Lung function was measured using a 'Powerlab' acquisition system. A rubber mouth piece was used to ensure a good seal and a nose clip was worn. Data were collected on three measurements in each position including forced vital capacity (FVC)<sup>15</sup> and forced expiratory volume (FEV),<sup>16</sup> with five breaths between each measurement.
- **Heart rate and blood pressure.** Heart rate and blood pressure were recorded using a continuous, live monitoring system attached to the participant's middle finger. Beat to beat digital arterial blood pressure (mmHg) was recorded using a Portapres Model-2 device and analysed using Beatscope 1.1a software. The height correction function<sup>17</sup> was used to correct any effects caused by changes in height as each participant leaned forwards. Participants remained in each restraint position for the duration of the three respiratory measurements described above and heart rate/blood pressure data for each position were recorded at the end of the whole period of time in the restraint position.
- **Participant rating of psychological experiences.** Immediately after physiological testing, the participants completed a series of rating scales (one form for each position). This allowed them to self-report various psychological and physical experiences resulting from their restraint, including sickness/nausea and feelings of stress or anxiety. The rating scale was based upon work by Roach et al. (1993) from their research on altitude sickness. Altitude sickness relates to inadequate oxygen levels, so it was therefore reasonable to look for similar experiences such as 'dizziness/light-headedness' in this study of the effects of restraint on breathing. The original rating scale was amended to include additional items specifically relevant to the current study, and the warning symptoms/signs used to monitor restraint in the secure estate for children and young people – including items on invasion of personal space and feeling safe and secure. The full rating scale is presented in Annex 2.

Following physiological testing of all the positions, each participant ranked the four head-hold techniques in terms of their personal preference. Participants placed photographs of the four head-holds in order of their preference and this order was recorded by the researchers. Participants were verbally instructed to base their rankings on their preference from the perspective of being restrained using these techniques, not from the perspective of the people applying the restraints. Participants

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<sup>15</sup> Forced vital capacity (FVC) is a measure of the volume of air which the lungs can hold. This is 'forced' – the volume of air when the person breathes in as much as possible then breathes out as much as possible.

<sup>16</sup> Forced expiratory volume (FEV) is a measure of the amount of air breathed out during a one-second period. Again, this is 'forced', meaning that the person does this to their maximum ability during the testing.

<sup>17</sup> Height correction function automatically corrects for pressure changes due to movement in hand position relative to the heart. Without this, a blood pressure sensor on a finger, which is held lower than the heart, will give a false high reading, and, when higher than the heart, will give a false low reading.

were also asked to rank the head-hold technique, and not the angle of lean. Ranking was carried out by each participant immediately after they had experienced all 12 of the test positions to ensure that their experiences of being restrained were fresh in their minds.

## Limitations of the study

No ethically acceptable laboratory study is able to fully replicate the varied and challenging circumstances experienced during real restraint incidents. However, it is difficult to gather detailed and accurate information from real-world situations and, to this end, laboratory studies offer a useful additional source of information on the effects of restraint.

The testing of two angles of lean was intended to assess the impact of being bent forwards on physiological measures and perceptions. The choice of two specific angles did not fully replicate the real-world situation, where the angle at which the young person is held may vary, for example, as a result of the relative heights of the staff and the young person. Use of two standard angles that were markedly different gave a consistency, which allowed for clear and accurate comparisons in this study.

The use of a purposive sample means that the results may not be representative of the wider population and, as such, need to be interpreted with some caution. They are, however, useful in providing an indication of the likely impact of using different head-hold techniques and any additional impact of leaning on young people.

The study was also designed to assess whether any effects on lung function would be greater in participants with higher BMI (body mass index). Although a range of participants was recruited (BMI range 20.4–35.2) to facilitate this, the absence of significant changes in lung function testing (see p.17) meant that this hypothesis could not be tested.<sup>18</sup>

## Ethical issues

The study was approved under the Coventry University ethics review procedure.<sup>19</sup>

All recruitment of participants, testing and analysis of results was conducted in the physiology laboratories at Coventry University. No YJB or NOMS personnel were present during the experimental work.

All participants were adult volunteers attending Coventry University. In order to avoid potential ethical concerns about conducting research on people who may not be able to give full voluntary or informed consent, no persons under the age of 18, detained persons or secure facilities were used in the study.

Participants were informed about the study verbally and in writing. Written consent and health declarations were given by all participants prior to taking part.<sup>20</sup>

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<sup>18</sup> It is noted that BMI has been demonstrated as being relevant in other studies (Parkes, Thake and Price, 2011) using the same methodology. However these studies were testing positions where the participants were much more sharply bent, often with the chest touching the knees.

<sup>19</sup> For further information, see <http://ethics.coventry.ac.uk/about/ethics-at-cu.aspx>

# Findings

The following section presents the main findings from the study. Ahead of conducting any statistical analysis, all results were checked for outliers<sup>21</sup> as these can distort the results of statistical testing. No such outliers were observed or excluded.

## Lung function

Repeated measures Analysis of Variance (ANOVA)<sup>22</sup> showed that there were no statistically significant<sup>23</sup> changes in lung function between restraint positions. Due to the large number of variables tested, there are some limitations with using this statistical technique. However, as shown in Tables 2 and 3, only small changes were recorded, which were considered consistent with those that might be experienced during normal life.

**Table 2: Mean and standard deviation for FVC (litres) across positions**

Position	1 (control)	2	3	4	5	6	7	8	9	10	11	12 (control)
Mean (litres)	4.21	3.95	3.79	3.64	3.90	3.91	3.96	3.76	3.93	3.86	3.87	4.11
sd	1.1	1.2	1.0	0.9	1.1	1.2	1.2	1.1	1.0	1.0	1.1	0.8

Note: Forced Vital Capacity (FVC) is a measure of the volume of air which the lungs can hold. This is 'forced' – the volume of air when the person breathes in as much as possible, then breathes out as much as possible.

The 12 positions are listed in Annex 1.

**Table 3: Mean and standard deviation for FEV 1.0% (%) across positions**

Position	1 (control)	2	3	4	5	6	7	8	9	10	11	12 (control)
Mean (%)	85.8	80.7	83.3	85.0	84.6	83.1	79.9	83.0	82.6	83.1	82.0	81.2
sd	8.6	13.5	12.6	11.3	11.1	13.3	16.6	13.5	11.6	14.0	14.8	10.4

Note: Forced Expiratory Volume (FEV) is a measure of the amount of air exhaled during a one-second period. This is 'forced', i.e. the person does this to their maximum ability. The figure is the percentage of FVC which could be breathed out during the first one second of forced expiration.

The 12 positions are listed in Annex 1.

<sup>20</sup> Participants were given a £20 gift voucher as a gratuity for attending to complete the study. Participants were informed that they were free to withdraw from the study or stop the testing without losing this gratuity (no-one withdrew at any time).

<sup>21</sup> An outlier is an extreme value/s that is distinct from the other values recorded.

<sup>22</sup> The data were checked using Shapiro-Wilk's test and visual inspection of the Q-Q plots. No issues arose. Data for FVC and FEV1.0% were analysed using one-way ANOVA with repeated measures (Microsoft Excel). Overall, no significant differences were observed for the whole group with respect to FVC ( $F(11, 231) = 0.426, P = 0.943$ ). Similarly, the results for FEV1.0% were not significant for the whole group ( $F(11, 231) = 0.410, P = 0.951$ ). There was no difference between control trials (Trial 1 =  $4.2 \pm 1.1$  litres; Trial 12 =  $4.1 \pm 0.8$  litres;  $P = 0.738$ ).

<sup>23</sup> Not 'statistically significant' means that the changes were so small that they may have occurred purely by chance, rather than reflecting any real change due to the position.

## Heart rate and blood pressure

No statistically significant changes in heart rate were identified (via repeated measures ANOVA) when testing the different restraint positions. Such analysis did, however, show small increases in mean blood pressure and in mean total peripheral resistance (resistance to blood flow through the blood vessels). Cardiac output (volume of blood pumped by the heart per minute) also varied slightly. Again, these were small changes which, while statistically significant,<sup>24</sup> could be experienced within normal daily life. There was also no clear pattern of greater or lesser effect depending on the restraint position being tested.

**Table 4: Mean cardio-vascular measurements across positions**

Position	SYS (mmHg)	DIA (mmHg)	MAP (mmHg)	HR ( bpm)	IBI (s)	SV (ml)	CO (lpm)	EJT (s)	TPR (MU)
1	113	71	87	93	0.667	83	7.6	0.254	0.74
2	112	72	88	92	0.669	82	7.4	0.258	0.78
3	114	73	90	92	0.673	82	7.4	0.259	0.78
4	112	71	87	92	0.669	85	7.7	0.260	0.73
5	109	70	85	95	0.646	80	7.5	0.252	0.74
6	112	72	88	93	0.658	77	7.1	0.254	0.80
7	109	69	85	92	0.670	82	7.4	0.257	0.73
8	111	69	86	92	0.667	85	7.7	0.261	0.71
9	112	72	88	96	0.641	83	7.8	0.257	0.72
10	113	73	89	93	0.660	82	7.5	0.258	0.76
11	114	74	90	93	0.666	79	7.2	0.256	0.83
12	113	72	88	91	0.676	81	7.3	0.253	0.78

Notes: See Annex 1 for a full list of the positions tested.

Abbreviations are as follows: SYS: Resting systolic blood pressure (mmHg)

SV: Stroke volume (ml)

DIA: Resting diastolic blood pressure (mmHg)

CO: Cardiac output (lpm)

MAP: Resting mean arterial pressure (mmHg)

EJT: Ejection time (msec)

HR: Heart rate (bpm)

IBI: Inter-beat interval (s)

TPR: Total peripheral resistance (MU)

Transient changes in blood pressure were detected while using the respiratory testing manoeuvres (forced breathing in and out) on restrained participants. This is illustrated in Annex 3 and appeared similar to those changes that might be expected with the Valsalva manoeuvre. The 'Valsalva manoeuvre' is a temporary, naturally occurring response of the body due to raised pressure in the chest. For example, if a person

<sup>24</sup> Significant main effects for restraint position were evident for diastolic blood pressure (DBP;  $F(11, 231) = 1.84$ ,  $P=0.049$ ); cardiac output (CO;  $F(11, 231) = 2.00$ ,  $P=0.029$ ) and total peripheral resistance (TPR;  $F(11, 231) = 2.16$ ,  $P=0.018$ ). However, post hoc analysis revealed no significant difference in DBP between any restraint positions; CO position 6 vs. position 10  $P=0.045$  only; and TPR position 11 vs. position 8  $P=0.02$  only. These differences between the stated restraint holds, although statistically significant, are very small and not considered to be of any clinical significance.

blows out while their mouth is closed and their nose pinched shut, this causes an increased pressure in the chest. This response occurs naturally, for example, when lifting a heavy weight. It is also used by doctors to assist in testing or diagnosing specific conditions.

Such transient changes in blood pressure have not been reported previously in restraint research and were therefore of interest. However, the relevance of these findings to the application of restraint techniques were not clear. In particular, they occurred within the artificial circumstances of the laboratory lung function testing. It is not certain that they would occur without the very specific pattern of forced breathing employed in this study (i.e. with the nose held closed using a nose clip, which is required during respiratory testing). The levels observed were also within the range likely to be experienced during normal life.

## Psychological experiences

Participants completed a rating scale form, assessing their psychological experiences immediately following physiological testing in each position (one form for each of the 12 positions). This form allowed participants to self-report various psychological and physical effects, including sickness/nausea and feelings of stress or anxiety (the form is shown in Annex 2).

There were statistically significant differences in participants' ratings between positions for the following items:

- pressure or pounding in the head
- difficulty breathing
- invasion of personal space
- overall discomfort.

Figures 1–4 show the mean (average) ratings of discomfort for each restraint position on a scale of 0 (none) to 4 (severe) for the statistically significant items.<sup>25</sup> While raw rankings were used for statistical testing, means have been presented to provide the reader with a more effective visual representation of the differences between positions. As such, the vertical axis show exaggerated scales intended to clearly display the small differences between each position. This may, however, make the ratings appear larger than they were. It should be borne in mind that, while the axis only goes up to 1.45, it was possible to score from 0 (none) to 4 (severe).

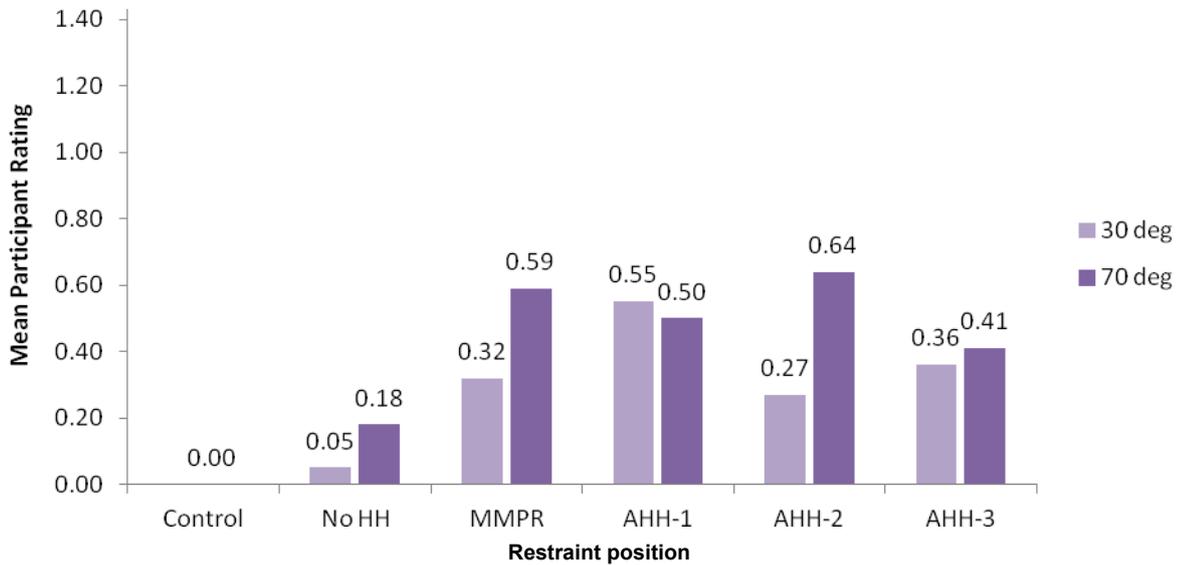
Figures 1–4 show that lower mean ratings were obtained for all positions at the 30 degrees angle (compared with the 70 degrees angle). Amended head-hold 2 at a 30 degrees angle had the lowest mean rating for two of the four items (pressure or pounding in the head and invasion of personal space), and the joint lowest for a third item (difficulty breathing).

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<sup>25</sup> Participant responses were statistically analysed using Friedman's analysis of variance (ANOVA). Statistical significance was set at  $P < 0.05$ .

## Pressure or pounding in the head

**Figure 3: Mean (average) of all participant ratings for ‘pressure or pounding in the head’ against position and angle of lean**

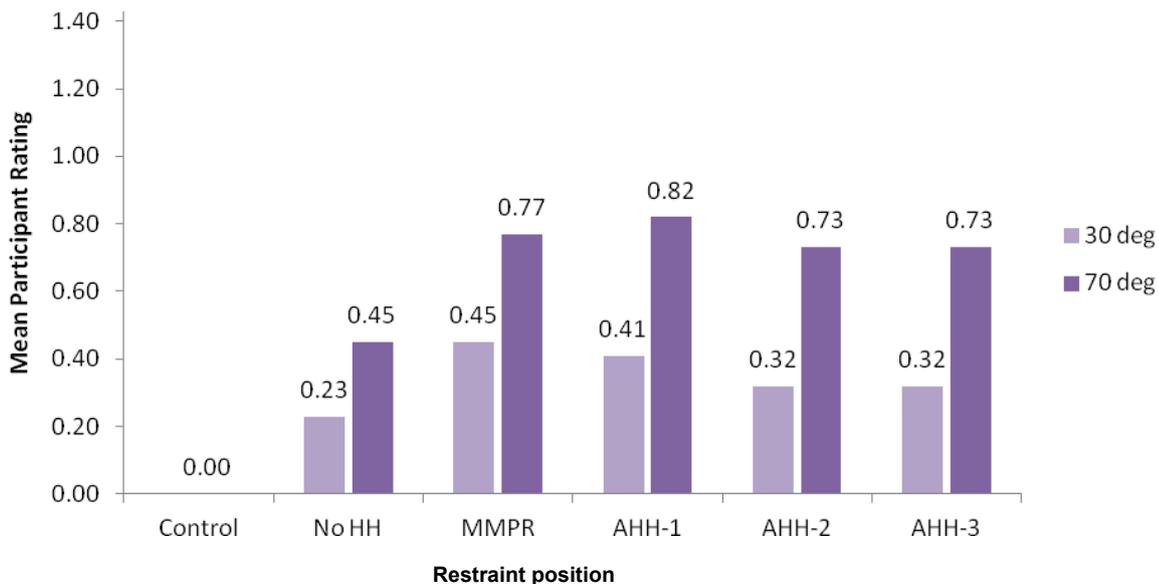


Note: Rating was on a scale of 0–4, where 0 is ‘none’ and 4 is ‘severe’. Means are shown as labels on each bar. (S = 19.02, DF = 10, P = 0.040)

No HH: No head-hold; MMPR: MMPR head-hold; AHH-1: Amended head-hold 1; AHH-2: Amended head-hold 2; AHH-3: Amended head-hold 3 (see illustrations on p.13-14)

## Difficulty breathing

**Figure 4: Mean (average) of all participant ratings for ‘difficulty breathing’ against position and angle of lean**

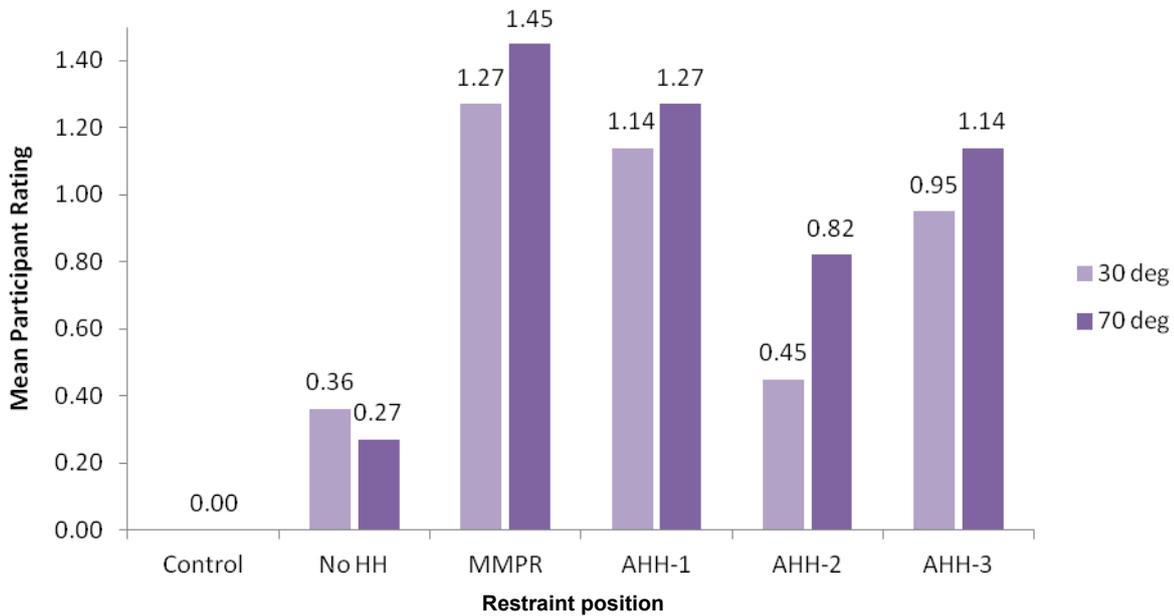


Note: Rating was on a scale of 0–4, where 0 is ‘none’ and 4 is ‘severe’. Means are shown as labels on each bar. (S = 25.80, DF = 10, P = 0.004)

No HH: No head-hold; MMPR: MMPR head-hold; AHH-1: Amended head-hold 1; AHH-2: Amended head-hold 2; AHH-3: Amended head-hold 3 (see illustrations on p.13-14)

## Invasion of personal space

**Figure 5: Mean (average) of all participant ratings for ‘invasion of personal space’ against position and angle of lean**

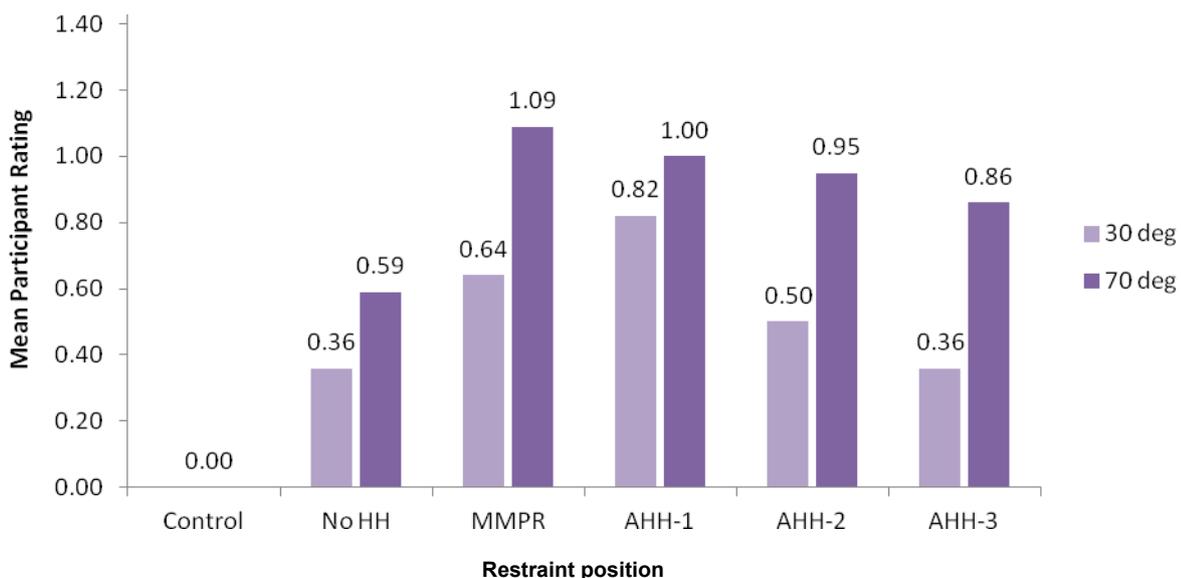


Note: Rating was on a scale of 0–4, where 0 is ‘none’ and 4 is ‘severe’. Means are shown as labels on each bar. (S = 72.07, DF = 10, P < 0.0005)

No HH: No head-hold; MMPR: MMPR head-hold; AHH-1: Amended head-hold 1; AHH-2: Amended head-hold 2; AHH-3: Amended head-hold 3 (see illustrations on p.13-14)

## Overall discomfort

**Figure 6: Mean (average) of all participant ratings for ‘overall discomfort’ against position and angle of lean**



Note: Rating was on a scale of 0–4, where 0 is ‘none’ and 4 is ‘severe’. Means are shown as labels on each bar. (S = 38.52, DF = 10, P < 0.0005)

No HH: No head-hold; MMPR: MMPR head-hold; AHH-1: Amended head-hold 1; AHH-2: Amended head-hold 2; AHH-3: Amended head-hold 3 (see illustrations on p.13-14)

## Preference ranking

Participants were asked to rank the four head-hold techniques in order of their personal preference. The ranking was carried out by each participant immediately after they had experienced all 12 test positions in order to ensure that their experiences of restraint were fresh in their minds. Each participant placed photographs of the four head-holds in order of their preference, which was recorded by the researchers.

Participants were verbally instructed to carry out their rankings based on their preference from the perspective of being restrained using these techniques, not from the perspective of the people applying the hold. Although participants had experienced each head-hold at both angles of lean, they were asked to rank the head-hold technique, and not the angle of lean.

Table 5 below shows how the participants ranked each head-hold technique from best to worst. It suggests that amended head-hold 1 ('Amended 1' in the table below) was least preferred by participants, while amended head-hold 2 was most favoured.

**Table 5: Number of participants ranking head-holds from 1 (best) to 4 (worst)**

	Position				
Ranking		1 (Best)	2	3	4 (Worst)
	MMPR	5	7	9	1
	Amended 1	3	0	2	17
	Amended 2	10	3	8	1
	Amended 3	4	12	3	3
	Overall order of preference	<b>Amended 2</b>	<b>Amended 3</b>	<b>MMPR</b>	<b>Amended 1</b>

Note: Bottom row shows overall rank order based on the rankings of all 22 participants. (Overall order based on number of participants who placed each head-hold in each ranking).  
(Statistical details: Chi-Sq = 59.273, DF = 9, P <0.005)

## Additional observations

While conducting this study, the authors observed that, if the restrained person's head was held firmly against the body of the person holding their head, there was potential for their neck to be bent, their chin pressed onto their own chest and their mouth to be held closed. This misapplication could potentially occur in any head-hold technique if the mouth is held closed and/or the neck is bent, although it is not consistent with the manner in which any of the head-holds are officially taught.

While the above misapplication would continue to allow an individual to breath through their nose, breathing through the mouth allows substantially greater volumes of air to

be inhaled/exhaled. The effects may not be significant when a person is at rest, but are likely to be at least highly uncomfortable if the person is 'out of breath' and may give rise to a perception that they cannot breathe. All restraints applied for purposes of this study were conducted in accordance with the demonstration given by a qualified MMPR instructor, and participants were breathing through their mouths during the testing. Therefore, the precise effects of misapplication could not be quantified.

It is recommended that the potential misapplication of restraint, resulting in the mouth being held closed, should be highlighted and warned against in MMPR training materials and explicitly emphasised during MMPR training.

# Conclusion

The aim of this laboratory-based research project was to compare the physiological and psychological impact of four different head-hold techniques, with a view to identifying the lowest risk approach. The overall conclusion drawn from this simulated study was that none of the head-holds, as tested, caused statistically significant changes in physiological measures, which would be beyond those that might be experienced in normal life.

The results for the specific physiological and psychological measures employed were as follows.

**Lung function:** The restraint positions did not result in statistically significant reductions in lung function, and the changes that were recorded were considered to be within the variation that might be expected during normal life.

The findings of this study are encouraging, as lung function testing has been shown to be a practical and effective method for assessing restraint positions in previous research (Chan et al., 1997; Michalewicz et al., 2007; Parkes and Carson, 2008; Parkes, Thake and Price, 2011; Barnett et al., 2013) with mean reductions of up to 50% reported (see Parkes, Thake and Price, 2011).

**Cardio-vascular:** Testing of cardio-vascular variables showed small changes which, while statistically significant, were deemed by the authors to be within levels that could be expected during normal life. The relevance of changes in variables such as heart rate, blood pressure or cardiac output is not as clear as the relevance of lung function, as the previous research literature is much more limited (Roeggla et al., 1997; Ho et al., 2011). Further research is therefore needed to fully understand the implications of such changes upon use of restraint in real-world settings.

**Psychological experiences:** While the physical safety of any restraint position is critical, it is also reasonable to try to reduce any discomfort experienced by young people to the minimum which is absolutely necessary. Psychological ratings in this study showed a statistically significant difference in participants' ratings between positions for some items (i.e. 'pressure or pounding in the head,' 'difficulty breathing,' 'invasion of personal space,' and 'overall discomfort'). However, the actual ratings of discomfort were relatively low (i.e. in no case rising above '3' and predominantly at '0,' '1' or '2' on a scale of 0–4, where '4' was described as 'severe.')

Overall, the statistically significant results from the ratings of participants' psychological experiences suggested a preference for amended head-hold 2, at an angle of 30 degrees. The preference for this head-hold was also supported by participants' rankings of their preference for the four head-hold positions.

Participants repeatedly rated the same restraint positions at 70 degrees as being more uncomfortable than at the more upright 30 degrees, both with or without a head-hold applied. While it may not always be possible to restrain a young person in an upright position during a real restraint incident (as this may fail to control behaviour such as kicking), it is reasonable to recommend that restraint be carried out in the most upright position which is possible in the circumstances.

Unlike the existing head-hold techniques used in the MMPR and Physical Control in Care (PCC) systems of restraint, which require the young person's head to be held against the body of a staff member, amended head-hold 2 allows the restrained person to be held at arm's length. This appears to have an advantage in allowing greater flexibility in the height at which the young person's head is held and changing this height to achieve the desired angle of lean. At present, the need to locate the head against the staff member's body may influence the positions possible, particularly if there is a substantial difference between the height of the staff member and that of the young person. Holding an aggressive young person at arm's length may also increase the safety of the staff member holding the head, by creating further distance from any restrained young person who remains able to kick while in a bent position.

At the time of writing, the authors were not aware of any testing to determine the practical effectiveness of this arm's-length technique. It would therefore be necessary to undertake further work to test for practical effectiveness. It is also noted that this study has shown only very small effects across the head-holds, and it would be unreasonable to adopt a technique based upon these small differences alone.

## Recommendations

The following recommendations regarding head-hold restraint techniques are based on the findings from the psychological ratings in this study, which suggest that to improve the comfort of those restrained, the following should be applied:

1. Restraint should be carried out in the most upright position which is possible in the circumstances.
2. A head-hold technique with the young person held at arm's length (amended head-hold 2) should be subject to further review and development by NOMS.

This technique should only be brought into operational use if there is confidence that it is safe (for staff as well as the young person) and effective.

In carrying out the study, the authors also identified a potential issue in using head-hold restraint techniques, which may have safety implications for their use:

3. The potential misapplication of restraint, resulting in the mouth being held closed should be highlighted and warned against in MMPR training materials, and explicitly emphasised during MMPR training.

# Annex 1: Positions tested

List of the 12 positions tested:

1. Standing, unrestrained (control position)
2. Standing, arms restrained, no head-hold, leant forwards 30 degrees
3. Standing, arms restrained, existing MMPR head-hold, leant forwards 30 degrees
4. Standing, arms restrained, existing MMPR head-hold, leant forwards 70 degrees
5. Standing, arms restrained, no head-hold, leant forwards 70 degrees
6. Standing, arms restrained, amended head-hold 1, leant forwards 30 degrees
7. Standing, arms restrained, amended head-hold 2, leant forwards 30 degrees
8. Standing, arms restrained, amended head-hold 3, leant forwards 30 degrees
9. Standing, arms restrained, amended head-hold 1, leant forwards 70 degrees
10. Standing, arms restrained, amended head-hold 2, leant forwards 70 degrees
11. Standing, arms restrained, amended head-hold 3, leant forwards 70 degrees
12. Standing, unrestrained (quality control to test for fatigue)

# Annex 2: Participant rating form

## Participant Rating Form

Participant No.	Position No.
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Thinking about your experience of this restraint position, please tick the appropriate box on the scales below.

Q1. Please indicate the degree to which you experienced the following while being restrained in this position:

	None				Severe
	0	1	2	3	4
Pressure or pounding in your head					
Dizziness/light-headedness					
Visual impairment e.g. blurred vision					
Sickness/nausea					
Mental confusion e.g. disorientation					
Difficulty breathing					
Chest compression/restriction					
Feelings of stress					
Feeling of panic					
Feelings of fear					
Feelings of anxiety					
Invasion of personal space					
Overall discomfort					

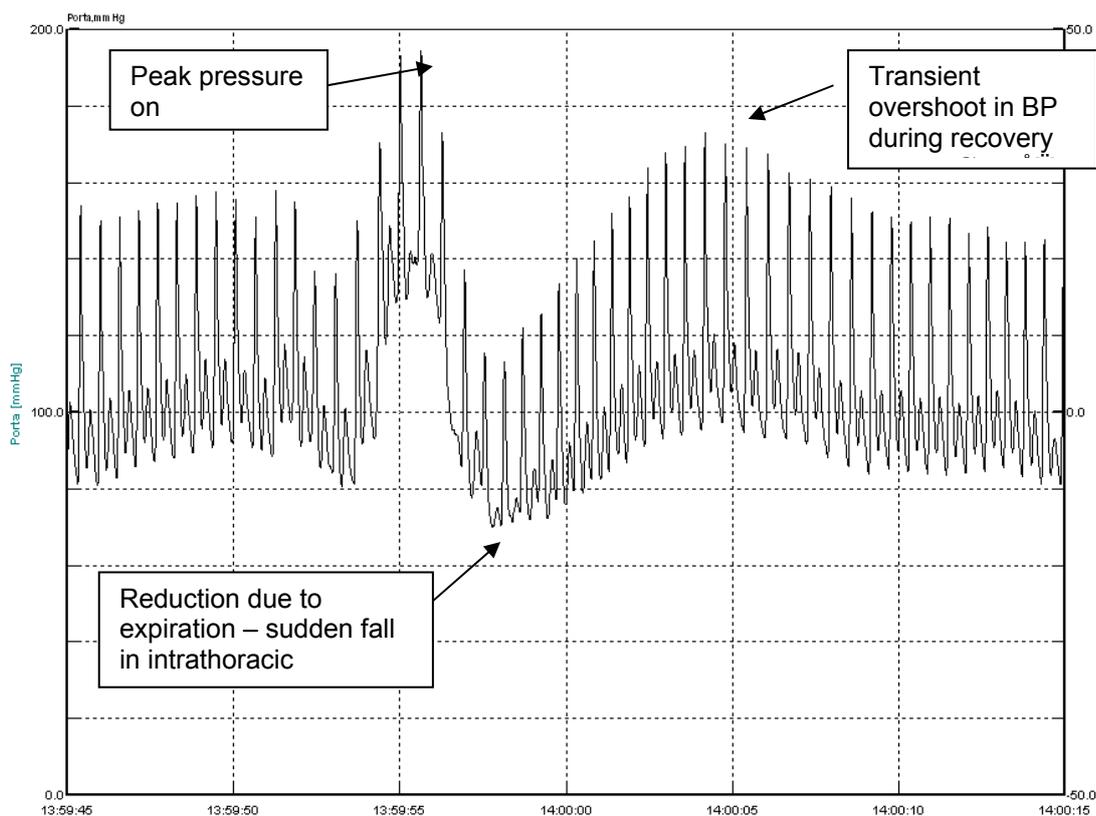
Q2. Please indicate the degree to which you experienced the following while being restrained in this position:

	Not at all				Extremely
	0	1	2	3	4
Feeling safe					
Feeling secure					

**Please use the space below to add any additional comments which you wish to provide on your experience during this restraint position (Including any issues not mentioned above)**

# Annex 3: Transient effects on blood pressure during respiratory manoeuvres

Table A3.1: Transient effects on blood pressure during respiratory manoeuvres



Sample blood pressure waveform trace from participant 21 when performing a forced expiration while in 70 degrees MPR head-hold restraint (participant 21 showed this effect most clearly). Y-axis = 0 to 200 mmHg, x-axis = time (hr:min:sec).

It shows peak pressure elevation on inspiration followed by a transient reduction on expiration and then a recovery overshoot. This appears similar to a Valsalva manoeuvre.<sup>26</sup>

<sup>26</sup> The 'Valsalva manoeuvre' is a temporary, naturally occurring response of the body due to raised pressure in the chest. For example, if a person blows out while their mouth is closed and nose pinched shut, causing an increased pressure in the chest. This response occurs naturally, for example if straining on the toilet or when lifting a heavy weight. It is also used by doctors to assist in testing or diagnosing specific conditions.

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